N71-37422

NASA TECHNICAL TRANSLATION

NASA TT F-13,786

SPACE MARATHON

V. Kitain, Compiler

Translation of: Kosmicheskiy Marafon (Special Issue of the "Biblioteka Izvestiy" Series), "Izvestiya" Press, Moscow, 1970, pp. 1-239.

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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
WASHINGTON, D. C., 20546 SEPTEMBER 1971

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DEDICATION

This book is dedicated to the glorious toilers in space, A. Nikolayev and V. Sevast'yanov, who completed an orbital flight of unprecedented length aboard the "Soyuz-9" spacecraft. These outstanding cosmonauts spent 18 days under conditions of weightlessness. They carried out an extensive program of scientific research and medical-biological experiments. The successful flight of the "Soyuz-9" craft marks a new step in the construction of long-lived orbital stations.

On the basis of the material presented on the pages of this book, the reader can follow the entire course of the flight of the "Soyuz-9" day-by-day. Commentaries by scientists will acquaint him with the problems which Soviet cosmonautics are solving.

Figure 1. Commander of the Soyuz-9, Andriyan Nikolayev.

Figure 2. Engineer of the Soyuz-9, Vitaliy Sevast'yanov.

CHAPTER 1. 1-19 JUNE 1970

Statement of A. G. Nikolayev, Commander of the "Soyuz-9" before the launch... /7*

Dear Comrades and Friends!

Today the crew of our ship, the "Soyuz-9" is going on a voyage in space to continue the important task of conquering outer space in the interest of the national economy, science and technology.

In our nation, work is going forward according to a planned schedule for the conquest of space. Aboard the Soyuz-9, we are going to take another step in the program of scientific and technical investigation and experimentation.

We shall do everything necessary to insure a successful performance of the tasks placed before us.

Farewell, comrades!

See you back on Earth!

Tass Reports /8

Soyuz-9 in Orbit

Spacecraft Piloted by Commander
Andriyan Nikolayev and Engineer
Vitaliy Sevast'yanov.

1 June

At 2200 hours Moscow time, the carrier rocket with the Soyuz-9 spacecraft was launched in the Soviet Union.

The spacecraft, which entered orbit around the Earth at 2209 hours, is piloted by the following crew: the commander, Hero of the Soviet Union, pilot

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*Numbers in the margin indicate pagination in the foreign text.

Cosmonaut of the USSR, Colonel Andriyan Grigor'yevich Nikolayev and the engineer, Candidate of Technical Sciences, Vitaliy Evanovich Sevast'yanov.

The task of the crew of the Soyuz-9 is to perform an extensive program of scientific research studies and experiments under the conditions of a single orbital flight; the most important of their tasks are the following:

--medical-biological studies involving the examination of the influence of space flight factors on the human organisms under conditions of life in orbit around the Earth;

--scientific observation and photography of geological and geographical objects, continental and water surfaces in various parts of the Earth in order to develop methods of using the data obtained for the national economy; /9

--observation, investigation and photography of atmospheric formations, snow and ice cover on the Earth in order to use the observation data in operative and long-range meteorological forecasting;

--scientific investigation of physical characteristics, phenomena and prophesies in the area of space near the Earth;

--further development of manual and automatic systems of control, orientation and stabilization of the craft and the testing of independent means of navigation in various flight modes.

Constant radio and television communication will be provided with the crew.

According to the reports of the commander of the craft, Comrade Nikolayev, the injection into orbit took place normally. The astronauts feel well. Normal life conditions, resembling those on the Earth, prevail aboard the craft.

The cosmonauts, Comrades Nikolayev and Sevast'yanov, have begun to carry out the planned program of the flight.

2 June

At 0512 hours, Moscow time, the Soyuz-9 spacecraft completed five revolutions around the Earth.

During the routine radio communication sessions, the commander of the craft, Comrade Nikolayev, reported that the crew was handling the conditions of weightlessness satisfactorily and was carrying out the planned program of the flight. The frequency of cardiac contractions in the case of Nikolayev during the first revolution amounted to 94 beats per minute, while for Sevast'yanov this figure was 92. The respiration frequency was 18 for both astronauts.

The parameters of the microclimate in the cabin of the spacecraft were as follows: temperature--23°C, pressure 765 mm Hg.

On the basis of the trajectory measurements, the parameters of the orbit on the third revolution were as follows:

--maximum distance from the surface of the Earth (at apogee)--220 km;

--minimum distance (at perigee)--207 km;

--period of revolution--88.59 minutes;

--inclination of orbit--51.7°.

The working day of the crew has ended, and the cosmonauts will rest from 0600 to 1400 hours Moscow time, 2 June.

At this time, the Soyuz-9 spacecraft will be outside the zone of radio communications with the territory of the Soviet Union.

At 1833 hours Moscow time, the craft completed 14 revolutions around the Earth. The cosmonauts were carrying out the program of the first working day of the flight in entirety. On the fifth revolution, the commander of the craft, Comrade Nikolayev, completed a maneuver involving manual orientation, after which the correcting engine was switched on. As the result of this operation, the spacecraft moved into a new orbit, whose parameters on the 14th revolution are as follows:

--the maximum distance from the surface of the Earth (at apogee)--267 km;

--the minimum distance from the surface of the Earth (at perigee)--213 km;

--period of rotation--89.05 minutes;

--inclination of orbit--51.7°.

In carrying out the program of the first day of the flight, Cosmonaut Nikolayev observed and photographed geological and geographical objects on the Earth's surface. Cosmonaut Sevast'yanov analyzed the contamination on the illuminators, produced by the operation of the engine assembly, and also determined the size of particles and various objects near the illuminators. In addition, he observed the light effects that were caused by the operation of the engine assembly.

Comrade Nikolayev began experiments that were connected with the study of the characteristics of man as an element in a control system in various dynamic operations.

At the set time, the cosmonauts had something to eat. They ate four times: breakfast, brunch, lunch and dinner. Following lunch, the crew took a short rest. Before going to sleep, they measured their arterial pressure and made entries in the logs regarding the events of the day.

From 0600 to 1600 hours, the Soyuz-9 was outside the zone of radio visibility from the territory of the Soviet Union.

At 1400 hours, the second working day of the cosmonauts began. During one of the radio communications sessions, the crew of the Soyuz-9 received greetings from the American astronaut, Neil Armstrong. Cosmonauts Nikolayev and Sevast'yanov thanked him for his good wishes.

Constant two-way communication is maintained with the Soyuz-9 spacecraft. Reports from the craft are transmitted on the following frequencies: 15.008, 18.06 and 20.008 MHz. The quality of the television pictures that are received is good. The information transmitted from the craft is being analyzed.

3 June /12

At 0630 hours Moscow time, the Soyuz-9 spacecraft completed 22 revolutions around the Earth. The second working day of the cosmonauts ended. The crew retains its high level of working ability and the condition of comrades Nikolayev and Sevast'yanov is good.

The temperature, pressure and relative humidity in the cabin of the craft are within the set limits.

On the 17th orbit following manual operation of the craft, an orbital correction was made. Following the correction, the spacecraft entered an orbit with the following parameters:

--maximum distance from the surface of the Earth (at apogee)--266 km;

--minimum distance (at perigee)--247 km;

--period of rotation--89.5 minutes;

--inclination of orbit--51.7°.

Having completed the work according to the program of the day for the flight, the crew made a medical check of the state of their health and entered the orbital section to rest. Until 1525 hours Moscow time, the Soyuz-9 spacecraft will be outside the zone of radio visibility of ground stations located on the territory of the Soviet Union.

At 1824 hours Moscow time, the Soyuz-9 spacecraft completed the 30th revolution around the Earth. Cosmonauts Nikolayev and Sevast'yanov are carrying out the program of scientific and technical experiments and studies for the third day of the flight.

The working day of the cosmonauts began at 1400 hours Moscow time. The cosmonauts had had a good rest and performed a set of physical exercises after they awoke. Andriyan Grigor'yevich and Vitaliy Ivanovich took particular pleasure in shaving in the orbital compartment and then they had breakfast. The latter included hot coffee, sandwiches and sublimated juices in tubes.

After breakfast, the cosmonauts proceeded to carry out the program of scientific and technical as well as medico-biological tests and operations involving control of the craft. On the 29th orbit, they carried out two medical experiments. In particular, they measured the level of the arterial pressure before and after physical stress and while carring out various working operations. The level of the arterial pressure was estimated with the aid of a tonometer. The pulse and respiration were measured at the same time. The administered physical load was applied with the aid of an expander and checked visually. While carrying out the experiment, one of the cosmonauts took movies, while the other stretched the expander 30 times a minute with a force of approximately 10 kg.

In addition, the cosmonauts checked the changes in the contrast sensitivity of the visual apparatus when working with instruments.

When the craft was in the region of the Equator, engineer Sevast'yanov performed some experiments in establishing radio communications on the short-wave frequencies with several ground measuring stations.

The crew of the spacecraft transmitted warm words of greeting to scientists, designers, engineers and workers--all of the builders of the Soyuz-craft.

According to the data from telemetric information, the frequency of the cardiac contractions for Nikolayev was 69 beats per minute while for Sevast'yanov it was 62; the respiration frequency was 12 per minute for both cosmonauts. Constant radio communication is being maintained with the crew.

4 June /14

At 0620 hours Moscow time, the Soyuz-9 spacecraft completed 38 revolutions around the Earth.

According to the program of the 3rd day of the flight, cosmonauts Nikolayev and Sevast'yanov observed celestial luminaries and conducted experiments in astronavigation with the aid of optical devices they had on board; they observed the relief of individual regions of the Earth's surface. The cosmonauts also performed tests of the sensitivity of the vestibular apparatus to the conditions of weightlessness.

According to the reports filed by the crew and the data from telemetric measurements, the on-board systems of the craft are functioning normally. Comrades Nikolayev and Sevast'yanov feel well, and they are in a good mood. The crew is retaining its high level of working ability. The hygeinic parameters in the cabin of the spacecraft are within the set limits.

In carrying out the program for this day of the flight, the crew carried out a medical check of their state of health and entered the orbital compartment for a rest.

Until 1530 hours Moscow time, the craft will be outside the zone of radio visibility for ground measuring stations located on the territory of the Soviet Union.

At 1815 hours Moscow time, the Soyuz-9 craft completed 46 orbits around the Earth.

At 1528 hours, following entrance of the craft into the zone of radio visibility of the ground tracking stations in the Soviet Union, the first session of radio communication for the fourth working day began. Commander Nikolayev said that both cosmonauts had slept soundly and peacefully. Their mood and condition are good.

Continuing to carry out the program of scientific and technical experiments, /15
Comrades Nikolayev and Sevast'yanov set up the apparatus for making manual orientations of the spacecraft by the stars.

When the craft was in the Earth's shadow, engineer Sevast'yanov located the star Vega and, using a system of manual orientation, used an optical sight to bring it into the field of vision of the star sensor. In the star sensor, the command "capture of star" was formulated. And Commander Nikolayev was able to stabilize the craft with gyro devices. At this time, cosmonaut Sevast'yanov measured the altitude of the star above the horizon with the aid of a sextant.

In addition, the cosmonauts carried out various medical experiments and tests during the flight. According to the telemetric data and the reports of the cosmonauts, they are maintaining a high level of working ability.

5 June

At 1507 hours Moscow time, the craft completed 60 revolutions around the Earth.

The next workday in space for Andriyan Nikolayev and Vitaliy Sevast'yanov lasted 16 hours and was performed in accordance with the established program. Performance of technical and medical experiments alternated with periods of taking nourishment, rest and physical exercise.

One of the technical experiments which was performed during the 48th and 49th revolutions was the testing of the accuracy of the uniaxial orientation of the craft with consideration of gravitational and aerodynamic disturbances. /16 For this purpose, cosmonaut Nikolayev manually oriented the ship in such a way that its transverse axis, lying in the plane of the panels of the solar batteries, was directed toward the Sun. Then he turned the ship relative to this direction.

Later on, orientation of the craft was maintained automatically using sensors of the angular velocity and the orientation motors. In the course of the experiment, photographs were taken of the movement of the image of the Sun on the screen.

During subsequent orbits, comrades Nikolayev and Sevast'yanov performed experiments in determining the parameters of the orbit using on-board devices.

To maintain their physical work capacity and intensive activity under conditions of weightlessness, twice each working day the cosmonauts carried out different carefully planned exercises lasting up to 50 minutes. They then recorded the frequency of the pulse and respiration.

According to the report of the commander of the craft, the pulse frequency of the cosmonauts was 68 for Nikolayev prior to physical exercise and 64 beats per minute for Sevast'yanov; following physical exercise, these figures were 88 and 90 beats per minute, respectively.

During the radio communications sessions, the cosmonauts reported that they felt well and that their working ability was high; they were in a very good mood.

After carrying out the program of the day, Andriyan Nikolayev and Vitaliy Sevast'yanov went to rest in the orbital section beginning at 0600 hours Moscow time.

In order to get some idea of the accuracy of operation of new radio systems for trajectory measurements, complex measurements of the parameters of the orbit were conducted on the 49th to 52nd revolutions of the flight by means of several measurement points located in the Soviet Union. On the basis of their results of the measurements, the orbital parameters of the Soyuz-9 spacecraft on the 50th orbit were as follows:

--maximum distance from the surface of the Earth (at apogee)--261.064 km; /17

--minimum distance from the surface of the Earth (at perigee)--241.638 km;

--period of rotation around the Earth--89.398 minutes;

--inclination of the plane of the orbit--51.722°.

At 1353 hours Moscow time, the first radio communications session of the new, 5th day of the flight began. Commander Andriyan Nikolayev said that the crew had rested well, felt normal and was ready to carry out the planned program of the next working day.

6 June

The fifth working day of the cosmonauts Andriyan Nikolayev and Vitaliy Sevast'yanov ended at 0500 hours Moscow time.

In the course of this day, the crew of the Soyuz-9 carried out the planned scientific and technical and medico-biological experiments and studies. In particular, they measured the moisture content in various parts of the living quarters of the craft by means of a checking and measuring device. On the 65th and 66th revolutions of the flight, they conducted an experiment to determine the accuracy of uniaxial orientation of the craft in a mode of passive torsion.

During one of the radio communications sessions, the cosmonauts talked about their observations and photography of the surface of the Earth. Engineer Vitaliy Sevast'yanov said that he had seen a tropical storm on the sunlit side

of the Earth. The waves of a coastal storm were clearly visible. Andriyan Nikolayev told of some interesting observations he made and some movies he took of the surface of the Earth and of the horizon during flight in the vicinity of the terminator--the boundary between night and day. During preceding days, /18 the cosmonauts had photographed the cloud cover of the planet. They observed a cyclone and storm phenomena.

The cosmonauts reported that they were sleeping in the orbital section, using sleeping bags, According to the cosmonauts, it was very comfortable sleeping in the bags. The conditions in the rest compartment of the craft were comfortable: temperature 24°C, pressure and relative humidity close to those on Earth.

The sleep of the cosmonauts was peaceful and as a rule without dreams. It lasted about 8 hours. After they awoke, the cosmonauts noted a feeling of cheerfulness, lightness, enthusiasm and a high level of working ability. Andriyan Grigor'yevich and Vitaliy Evanovich said that they had a good appetite and that they were satisfied with the space food.

Various natural and preserved products were included in the food ration of the cosmonauts; the first course consisted of sorrel soup, borshcht, soup, and other things. The first course and coffee were prepared immediately before use. Second courses were also included in the assortment--steak, chicken, chopped pork with egg, and ham. The cosmonauts were particularly happy with the tasty fruit juices they had.

Andriyan Nikolayev and Vitaliy Sevast'yanov are very interested in events on Earth, they follow the sports, especially the World Cup games, and listen to music with great pleasure.

At the end of the working day of the flight, comrade Nikolayev oriented the ship so that the planes of the solar batteries were at an angle of 70° relative to the Sun. This position of the craft was selected according to the conditions of the planned regime, charging the on-board power sources in view of the low consumption of electrical energy during the hours the crew was resting.

Then the ship was twisted relative to the selected direction at an angular velocity of 3° per second. /19

At 1300 hours Moscow time, a new (6th) day of flight began for the crew of the Soyuz-9. The state of health of the cosmonauts was good and they were feeling fine. Cosmonauts Nikolayev and Sevast'yanov are carrying out the program of experiments and studies of the day.

7 June

At 1200 hours Moscow time, the Soyuz-9 spacecraft completed 90 revolutions around the Earth.

The sixth working day of cosmonauts Andriyan Nikolayev and Vitaliy Sevast'yanov lasted from 1306 hours to 0500 hours on the 7th of June. In accordance with the planned program, the crew of the ship made observations of the Earth's surface and celestial luminaries, carrying out scientific and medical experiments.

During the radio communications sessions, the cosmonauts reported the results of visual observations. The surface of the planet along the flight path of the craft was about 80% covered by clouds, so that observations of individual regions of the Earth were largely prevented. Flying over Africa on the 6th of June at approximately 1800 hours, engineer Sevast'yanov saw the light of forest fires. In the same area, he could clearly see Mount Kilimanjaro, covered with snow, with the dark crater at the center, as well as the large lake Tanganyika, Nyasa, Victoria and the falls.

Vitaliy Sevast'yanov reported some interesting observations he made of celestial luminaries. Looking into the starry sky in the direction opposite to the Sun, the cosmonauts observed simultaneously the illuminated Earth, the constellation of the Southern Cross, the stars Alpha and Beta Centauri, Canopus, Sirius and others. The phases of the setting and rising of the Sun were very interesting, the cosmonauts said.

During the flight, engineer Sevast'yanov checked the state of the surface of the illuminators of the craft, photographed them and reported the results of his observations to the flight control center. As part of the medico-biological /20

program of the sixth day, the cosmonauts performed experiments to study the fundamental biological processes under conditions of weightlessness, and also investigated the muscular strength of their hands. The second experiment was performed in order to obtain data for an indirect determination of the tonus of the skeletal musculature of man under conditions of space flight. The medical data, obtained by telemetry, as well as the results of mutual medical monitoring by the members of the crew indicate that cosmonauts will be able to withstand the complex effect of spaceflight factors well and will retain their high working ability. The frequency of the cardiac contractions of the commander of the craft was 69 to 72, while those of the engineer were 65 and 66 beats per minute; the respiration frequency for both cosmonauts was 12 per minute. The level of the arterial pressure for Nikolayev was 125 over 75, while for Sevast'yanov it was 120 over 70 mm Hg. According to the telemetric data, the parameters of the microclimate in the cabin of the spacecraft were as follows: temperature--22°C, pressure--830 mm Hg, partial pressure of oxygen and carbon dioxide--195 and 8.5 mm Hg, respectively.

At 1340 hours Moscow time, the first radio communications session began for the 7th day of the flight. Commander Andriyan Grigor'yevich Nikolayev reported that the crew felt normal and was ready to carry out the program of the next working day.

8 June /21

The crew of the Soyuz-9 spacecraft is in the 7th day of its orbital flight. At 1437 hours Moscow time, the craft completed 108 revolutions around the Earth.

The program of the 7th working day of the flight involved scientific experiments in the study of the space near the Earth and medical investigations of the state of the organism of the cosmonauts.

One of the scientific experiments that was performed by the cosmonauts during the day was the photography and spectrometric examination of the crepuscular and diurnal horizon of the Earth. The purpose of this experiment was to study the brightness structure of the atmospheric layer for a precise determination of the line of the horizon, used as a point of orientation in navigation of spacecraft.

During the flight over the dark side of the Earth, e.g., Nikolayev oriented the craft by lining up the axis of the optical illuminator with the crepuscular horizon of the Earth. Then engineer V. I. Sevast'yanov took a spectrophotometric picture of the horizon, beginning with the moment of appearance of the glowing aureole in the Earth's atmosphere, until the Sun rose above the horizon.

The spectral photometric recording of the diurnal horizon was performed during the flight over the illuminated side of the Earth. The experiment consisted of several successive series of spectrometric measurements, performed during rotation of the craft around a local vertical. At the same time, the crew photographed the horizon.

During the day, the cosmonauts performed a complex of physical exercises on two occasions, each lasting about 1 hour.

Continuing the program of medical investigation, the cosmonauts studied /22
the influence of factors of spaceflight on the human organism. With the aid of various functional samples and psychophysiological tests, they determined the state of the organism of the members of the crew in the level of their working ability.

The medical data obtained along the telemetry channels, the result of the tests performed by the members of the crew on themselves and each other, and the data from the television observation of the cosmonauts indicates that after 7 days they are withstanding the complex influence of spaceflight factors well, retaining a high level of working ability. During the 7 days of the flight, the frequency of the cardiac contractions has been as follows: Nikolayev--68, Sevast'yanov--64 per minute, with respiratory frequency 12 per minute for both cosmonauts.

The next working day for A. G. Nikolayev and V. I. Sevast'yanov began at 1230 hours Moscow time on 8 June. Commander A. G. Nikolayev reported that the crew felt well and that they were ready for work.

9 June

At 1425 hours Moscow time, the Soyuz-9 spacecraft completed 124 orbits around the Earth. At this time, cosmonauts Andriyan Nikolayev and Vitaliy Sevast'yanov had been in orbital flight for 186 hours.

The 8th working day of the Soyuz-9 crew was spent in accordance with the established program and ended on 9 June at 0430 hours Moscow time. During the day, cosmonauts Nikolayev and Sevast'yanov performed scientific and technical experiments, observed the Earth's surface and celestial luminaries, and also carried out a number of medical tests.

During the radio communications sessions, Andriyan Nikolayev and Vitaliy /23
Sevast'yanov reported on the performance of the experiments and the results of the visual observations. On this particular day, the continents of South America and Africa were particularly accessible to observation. They could clearly follow the western coast of the American continent, the Valley of the Amazon River, and Lake Chad in Africa.

On the 96th revolution, when they were performing an experiment to determine the parameters of the orbit by means of on-board systems, the cosmonauts selected as a reference point Lake Viedma, located in South America. Commander Andriyan Nikolayev oriented his craft with an optical illuminator to the Earth. After which engineer Sevast'yanov performed navigation measurements, entering them and other raw data into the calculating formula and computed one of the parameters of the orbit.

In accordance with the program of the 8th day of the flight, the crew of the Soyuz-9 also performed medical tests, intended to investigate possible changes in the sense organs and the working ability of the cosmonauts under conditions of weightlessness.

On the 111th revolution, cosmonaut Nikolayev performed a set of physical exercises for 1 hour, and then recorded the results of measurements of physiological indicators before and after physical stress. Before carrying out the exercises, the level of arterial pressure for Nikolayev was 125 over 75 mm Hg, while the frequency of cardiac contractions was 68 per minute and respiration 11 per minute.

Twenty seconds after physical stress, the level of the arterial pressure increased to 135 over 70 mm Hg, pulse rate rose to 80 per minute, and respiration rose to 15 per minute. Two minutes later, the cosmonaut noted a return of these physiological parameters to the original levels.

Hence, the recorded physiological indicators show that the reactions of /24
cardiovascular and respiratory systems to the physical load imposed on them was adequate. In the cosmonaut's words, after carrying out the exercises he experienced a pleasant feeling and felt as well as he did after doing physical exercises on Earth.

On 8 June, at 2220 hours, during a television broadcast from the Satellite, Andriyan Grigor'yevich Nikolayev talked with his family. Valentina Vladimirovna and her daughter Alenka, who was six years old on that day, wished Andriyan Grigor'yevich success and a safe return to Earth.

The next workday aboard the Soyuz-9 began at 1230 hours Moscow time on the 9th of June. During the first radio communications session, the commander reported that the cosmonauts felt well after their rest and they were ready to carry out the program of the day.

10 June

The crew of the Soyuz-9 craft has been in orbital flight for 9 days. At 1430 hours Moscow time, the Soyuz-9 completed 140 revolutions around the Earth.

The next workday of cosmonauts Andriyan Nikolayev and Vitaliy Sevast'yanov lasted about 16 hours and finished at 0430 hours. In the course of the day, the crew performed technical experiments and also carried out medical tests.

On the 127th-128th revolutions of the flight, the cosmonauts tested the star sensor, which works on a new principle. When they were above the dark side of the Earth, the cosmonauts tried to find the star Vega and oriented the craft toward Vega by means of the star sensor. This position of the craft was maintained from then on with the aid of the orientation motors and the gyroscopic devices. After performing a complete revolution around the Earth, the star sensor again "caught" the star Vega.

During the radio communications sessions, cosmonauts Nikolayev and Sevast'yanov reported that they felt well and had slept deeply. Andriyan Nikolayev prefers to sleep in the orbital section, where the temperature is about 24°C, while Sevast'yanov would rather sleep in the cabin, which is much cooler.

According to the cosmonauts, they have a good appetite. They use the required amount of liquid in the form of drinking water, fruit juices, soup and coffee. According to telemetric data and television observations, the state of health of the cosmonauts is good and their working ability is high.

The next working day of the Soyuz-9 crew began at 1200 hours Moscow time on the 10th of June. During the radio communications session, Andriyan Nikolayev reported that the cosmonauts were ready to carry out the designated program after they had rested.

11 June

At 1231 hours Moscow time, the Soyuz-9 spacecraft completed 155 revolutions around the Earth. Cosmonauts Andriyan Nikolayev and Vitaliy Sevast'yanov had been in orbital flight for 230 hours.

The working day of Andriyan Nikolayev and Vitaliy Sevast'yanov began at 1200 hours Moscow time and proceeded in complete accordance with the established program. Following their morning toilet, the checking of the ship's systems and breakfast, the cosmonauts busied themselves with observations of the Earth's surface and celestial luminaries. During the radio communications sessions, Nikolayev and Sevast'yanov reported that they had sighted the Crimea and Caucasus, and that the cities of Sochi and Batumi as well as Lake Sevan were clearly visible. On the 143d revolution, the cosmonauts spotted a dust storm in the vicinity of the Deshte-Kevir desert in the territory of Iran. /26

During the 10th day of the flight, A. Nikolayev and V. Sevast'yanov rested more than on preceding days, in accordance with the program. Following their brunch, they played chess and read books. The cosmonauts reported that they had held a general housecleaning in the living quarters of the craft; they had collected dust and small particles with the aid of a vacuum cleaner.

The parameters of the microclimate aboard the Soyuz-9 are normal, close to those on Earth; the pressure is 850 mm Hg and the temperature is 20°C.

Before lunch, Nikolayev and Sevast'yanov spent some time doing space gymnastics in the orbital section. At the end of the workday, the cosmonauts checked one another's physical conditions. During the last radio communications session, commander Nikolayev reported that the cosmonauts had had a good rest during the day. They felt well and were in good spirits. Before going to sleep, the pulse rate for Nikolayev was 68 while that for Sevast'yanov was 67 beats per minute, and their respiration frequencies were 12 and 15 per minute, respectively.

The next working day of the Soyuz-9 crew began at 1100 hours Moscow time. Andriyan Nikolayev reported to the flight control center that the crew was ready to carry out the program of the day.

12 June /27

The crew of the Soyuz-9 spacecraft has been or orbital flight for 11 days. At 1346 hours Moscow time, the craft completed 172 orbits around the Earth.

The program of the past 11 days of flight was filled with scientific and technical experiments. In particular, the crew performed a series of photographic and spectrometric studies, combining them for the general purpose of studying the surface of the Earth and its atmosphere under conditions of spaceflight. Experiments were conducted by several methods using diverse recording and photographic apparatus.

Cosmonauts Nikolayev and Sevast'yanov performed observation and photography of the cloud and snow covers of the Earth. This experiment was conducted in order to study the spatial structure of clouds and to determine the limits of deposits of snow and ice. Initially, the craft was oriented with the aid of an optical sight with respect to the Earth, and then, during stabilized flight over selected regions, engineer Sevast'yanov photographed and made spectrophotometric recordings of the characteristic cloud and snow formations.

During the flight, the crew of the Soyuz-9 photographed the diurnal and crepuscular horizon of the Earth, as well as the Moon against the background

of the Earth's horizon. On the 159-161st revolutions of the flight, cosmonauts Nikolayev and Sevast'yanov photographed individual regions of the Earth's surface with characteristic local relief from the geological standpoints.

The cosmonauts ate their food according to an established regime and enjoyed it. During the day, they also carried out a number of medical experiments. The cosmonauts used a spring dynamograph to study the muscle-joint sensitivity. They determined the accuracy of maintaining a given muscular force by the cosmonauts.

According to the telemetric data from the psychophysiological analysis of the actions of the crew, functional samples, radio conversations, as well as observations made during the television transmissions and the reports of the cosmonauts themselves, their state of health and mood were good and their working ability was high.

At 1230 hours Moscow time, the first radio communications session of the new day of the flight was held. Commander Andriyan Nikolayev reported that the crew felt well after its rest and was ready to carry out the planned program of the day.

13 June

At 1332 hours Moscow time, the Soyuz-9 spacecraft completed 188 orbits around the Earth. Cosmonauts Andriyan Nikolayev and Vitaliy Sevast'yanov had been in orbital flight for 12 days.

The working day of the cosmonauts lasted about 16 hours and finished at 0430 hours on the 13th of June. The program included performance of scientific and technical as well as medical experiments. One of the technical experiments was a repeated test of the star sensor, working on a new principle. The tests involved setting the sensor for astro-orientation using the star Canopus. The experiment proceeded successfully: the star Canopus was detected by the sensor at the calculated time.

When the Soyuz-9 was in the area of the Equator, the cosmonauts performed /29
experiments to establish radio communications with ground measuring stations on the shortwave frequency.

During the flight of the spacecraft, measurement of its orbital parameters were made regularly by devices in the ground command-measurement complex. The orbital parameters on the 181st revolution were as follows:

--maximum distance from the surface of the Earth (at apogee)--246.7 km;

--minimum distance from the surface of the Earth (at perigee)--231.2 km;

--period of revolution--89.1 minutes.

According to the program of medico-biological studies, the crew of the spacecraft performed biological experiments to study the multiplication and growth of insects, details of cell division in Chlorella, sporogenesis in flowering plants and bacterial cultures in liquid media.

During the radio communications sessions, Andriyan Nikolayev and Vitaliy Sevast'yanov reported that the program was proceeding successfully, they were in a good mood, their working ability was high and their appetites and sleep were normal. According to the telemetric data and the reports of the cosmonauts themselves, the pulse frequency for Nikolayev was 68 on the average while for Sevast'yanov it was 62 per minute. The respiratory frequency was 15 per minute and the arterial pressure was 120 over 75 mm Hg for both cosmonauts.

The new (13th) working day was begun by cosmonauts Andriyan Nikolayev and Vitaliy Sevast'yanov at 1200 hours Moscow time. During the radio communications session, the cosmonauts reported that they felt well and were ready to carry out the program of the next day.

14 June /30

The crew of the Soyuz-9 spacecraft has been in orbital flight for 13 days. At 1316 hours Moscow time, the craft completed 204 revolutions around the Earth. At this time, cosmonauts Andriyan Nikolayev and Vitaliy Sevast'yanov had been in spaceflight for 303 hours.

The 13th working day in space was passed in accordance with the established program and completed at 0300 hours Moscow time on the 14th of June. Cosmonauts Nikolayev and Sevast'yanov performed scientific-technical and medical experiments in the course of the day.

One of the scientific experiments involved a study of the dynamic functions of man, reviewed as an element of a model of a control system. In this experiment, a special cybernetic device was used, which made it possible to simulate complicated dynamic flight modes. During the experiment, conducted by engineer Sevast'yanov, the accuracy with which he performed a given program of commands for controlling the cybernetic device was determined. Similar experiments were conducted during the ground training and at the beginning of the flight. A comparison of the results obtained made it possible to get an idea of the complex influence of factors of spaceflight on the investigated human characteristics.

During the day, the cosmonauts performed observations and photographed the Earth's surface. On the 188th revolution, cosmonauts Nikolayev and Sevast'yanov photographed the cloud formations in the western part of the Aquatorium of the Indian Ocean. This experiment also involved the scientific research vessel of the Academy of Sciences of the USSR, the "Academician Shirshov" and observations were made with the aid of the meteorological satellite "Meteor."

During the radio communications sessions, Andriyan Nikolayev told about /30
his observation of several small meteorites which entered the atmosphere of the Earth and burnt up in it. The commander of the craft also described in detail the state of the illuminators in the orbital section.

The cosmonauts carried out a number of medical experiments, especially involving a study of contrast sensitivity of the eyes during work with devices under conditions of prolonged weightlessness. The experiment was conducted with ordinary working illumination in the orbital section twice in the course of the day--before going to sleep and after waking up.

The next day in the flight of the crew of the Soyuz-9 craft began on 14 June earlier than usual, in conjunction with an international holiday--the day of elections to the Supreme Soviet of the USSR. At 0815 hours Moscow time, the cosmonauts sent a radiogram, addressed to the Soviet people. In the concluding portion of the radiogram, they said: "On this solemn day, we join the entire Soviet people in voting for the continued flourishing of our socialist motherland, our Communist Party, and for Communism."

During the radio communications session, Commander Andriyan Nikolayev reported that the crew had completed the program for the day. The cosmonauts were in a good mood.

Radiogram Transmitted from the Spacecraft

On the day of elections of the Supreme Soviet of the USSR--14 June--at 0815 hours Moscow time, cosmonauts A. G. Nikolayev and V. I. Sevast'yanov transmitted the following radiogram from the Soyuz-9 spacecraft, addressed to the Soviet people:

Dear Comrades!

Today, the 14th of June, when the entire Soviet people is electing the deputies of the highest organ of state power in our country, we, the members of the crew of the Soyuz-9 spacecraft, now in the reaches of space, aware of our serious civil obligation to take part in all elections, cast our votes for the best sons and daughters of our homeland, the candidates of the firm alliance of Communists and non-Party people. On this solemn day, we join the entire Soviet people in voting for the continued flourishing of our socialist motherland, our Communist Party and for Communism."

/s/ Commander of the Soyuz-9,
A. G. Nikolayev and

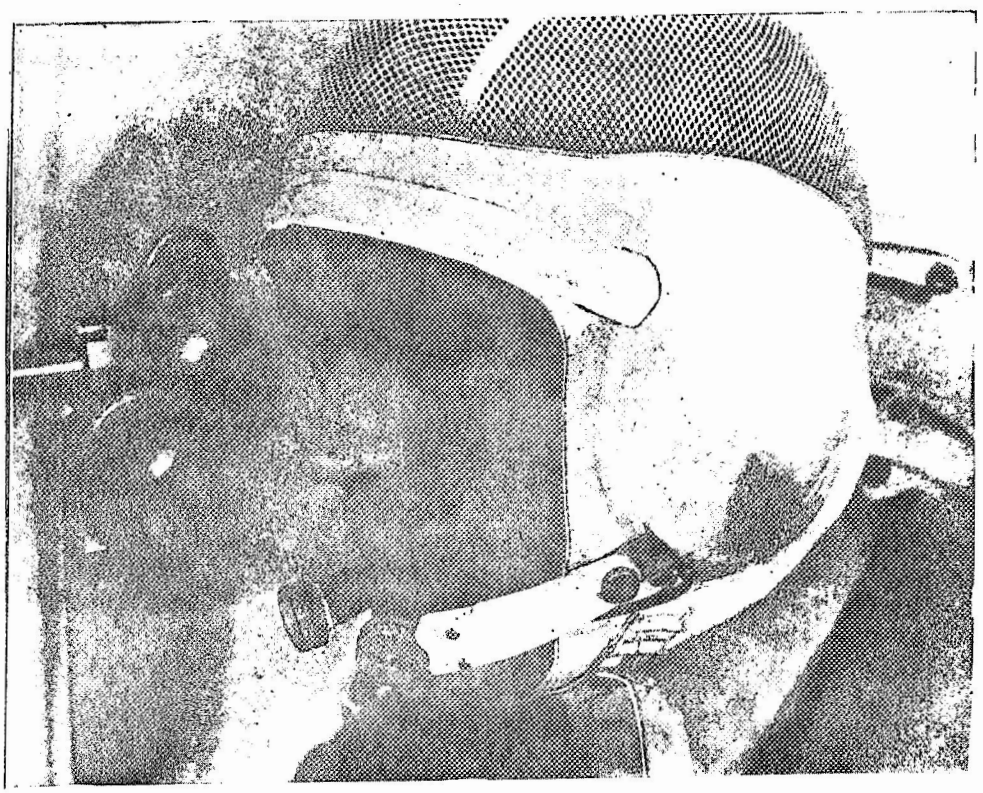
Engineer of the Soyuz-9,
V. I. Sevast'yanov

15 June /32

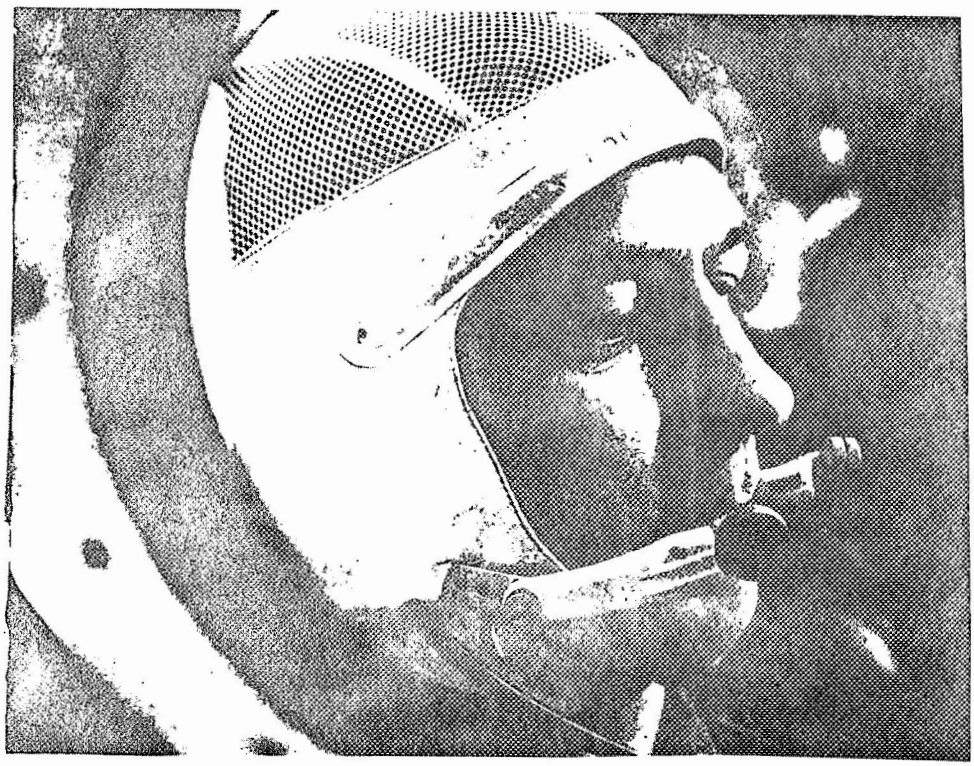
At 1300 hours Moscow time, the Soyuz-9 spacecraft completed 220 revolutions around the Earth. At this time, cosmonauts Andriyan Nikolayev and Vitaliy Sevast'yanov had been in orbital flight for 327 hours.

The 14th working day of the cosmonauts ended at 0315 hours. In accordance with the planned program, the cosmonauts performed scientific and technical experiments, performed medical checks of the state of their health and also corrected the orbit of the craft.

Only a Few Days Remain Before the Flight.



Andriyan Nikolayev is no Novice in Space, but he Scrupulously Carries Out the Entire Program of Preflight Training.



Engineer Vitaliy Sevast'yanov has Repeated the Entire Flight on the Ground Many Times With His Commander.

There Will Be No Doctor Aboard the Spacecraft On This Flight. They have to learn to carry out their own medical checks in orbit.

At the beginning of the working day, Andriyan Nikolayev and Vitaliy Sevast'yanov had their breakfast and did their physical exercises; they then observed and photographed the surface of our planet. The African continent was most accessible to observation. The cosmonauts could clearly see and photograph the valley of the Nile River and the Aswan Dam.

On the 208th revolution, the crew made a correction to the orbit of the craft. To check the system for controlling orientation of the craft, before switching on the engine assembly, they worked both in the manual and automatic regimes. /33

After correction, the parameters of the orbit of the Soyuz-9 spacecraft were as follows:

--maximum distance from the surface of the Earth (at apogee)--231.4 km;

--minimum distance from the surface of the Earth (at perigee)--215.1 km;

--period of revolution--88.8 minutes.

The crew of the Soyuz-9 spacecraft has been in flight for 14 days. Under conditions of prolonged weightlessness, the cosmonauts have carried out a large volume of scientific, technical and medical experiments. Each working day of the cosmonauts as a rule lasted about 16 hours and was characterized by intensive activity under stress.

During this period a medical check was regularly performed to determine the state of health of the crew, including data from observations of the cosmonauts during the television sessions, radio conversations, telemetric information and the reports of the cosmonauts themselves.

An analysis of the results of the medical check indicates a good toleration of the conditions of prolonged spaceflight by both cosmonauts. The working ability of Andriyan Nikolayev and Vitaliy Sevast'yanov remained at a sufficiently high level. Their mood and condition remains good.

On the 15th working day, the crew of Soyuz-9 began working at 1030 hours Moscow time. During the radio communications session, Commander Andriyan Nikolayev reported that the cosmonauts felt well after their rest and were ready to carry out the program of the day.

16 June /34

At 1407 hours Moscow time, the Soyuz-9 spacecraft completed 237 revolutions around the Earth. At this time, cosmonauts Andriyan Nikolayev and Vitaliy Sevast'yanov had been in orbital flight for 352 hours. This was the first time that such a flight in space had lasted so long.

The past working day of the cosmonauts proceeded in accordance with the established program and ended at 0316 hours.

Following breakfast and a medical checkup, Vitaliy Sevast'yanov took some movies of Andriyan Nikolayev doing his physical exercises, after which he himself spent an hour doing physical exercises.

On the 222nd revolution, the cosmonauts used a manual device to orient the craft so that one of the illuminators of the orbital section was directed toward the Earth. During the flight on the 222nd-224th revolutions, the required orientation was maintained by Commander Andriyan Nikolayev by means of a manual system of control. During this time, Vitaliy Sevast'yanov took some photographs of the geological and geographical objects in the areas of the southern part of the European territory of the USSR, Kazakhstan and western Siberia.

At the same time as the experiments performed in space, photographs were being taken from aircraft in these areas for purposes of geological prospecting.

During the day, the cosmonauts observed some celestial luminaries. Vitaliy Sevast'yanov observed the stars Arcturus and Deneb in the constellations Bootes and Cygnus. He measured the angles between them and the line of the horizon. The results of the navigational measurements were used in determining the parameters of the orbit of the craft.

On the basis of the reports of the members of the crew, the television /35
observations made of them, the data from telemetric information and the results of carrying out the program of the day, the working ability of the cosmonauts continues to remain high. They are withstanding a period of many days in a state of weightlessness in good shape. Comrades Nikolayev and Sevast'yanov note that they have become accustomed to weightlessness and feel as well and able as when they were training under terrestrial conditions.

The next (16th) working day in space began at 1100 hours Moscow time. During the radio communications sessions, the commander of the craft, Nikolayev, reported that after their rest the cosmonauts felt well. The crew has begun to carry out the program of scientific and technical experiments. The on-board systems are functioning normally and are providing conditions close to those on Earth in the living quarters of the craft.

17 June

The crew of the Soyuz-9 spacecraft has been in orbital flight for 16 days. At 1345 hours Moscow time, the craft completed 253 revolutions around the Earth. The length of A. G. Nikolayev and V. I. Sevast'yanov's stay in outer space is 375 hours as of the present time.

The 16th working day in space ended at 0300 hours on 17 June. In accordance with the program, the cosmonauts spent today carrying out scientific and medical experiments.

During the day, Andriyan Nikolayev and Vitaliy Sevast'yanov performed observations of the Earth's surface and photographed several cloud formations and regions with a characteristics local relief from the geological standpoint.

During the radio communications sessions, cosmonaut Nikolayev and /36
Sevast'yanov reported the results of their observations. They had a good view of the islands and coastline of the Mediterranean Sea, the Crimea and the Black Sea coast of the Caucasus, the delta of the Volga River, and parts of western Siberia.

The cosmonauts were able to see clearly the cities which are located in these areas: Athens, Istanbul, Yalta, Sochi, Astrakhan and others.

Flying over Kazakhstan and western Siberia, Nikolayev and Sevast'yanov reported a gradual increase in the density of the cloud cover and the formation of a cyclone in the area of Novosibirsk. After passing through the terminator to the dark side of the Earth, the cosmonauts got a good view of cloud formations in the moonlight.

At the beginning and end of the workday, Andriyan Nikolayev and Vitaliy Sevast'yanov performed medical experiments. In particular, by using a dynamometer, they measured the muscular force of their hands and also used a spring dynamograph to examine the sensitivity of their muscles and joints.

During the day, the cosmonauts checked one another's health, measured the arterial pressure, and recorded the pulse and respiration.

According to the telemetric data in the reports of the cosmonauts, the values of these physiological indices were as follows: arterial pressure for Nikolayev, 125/80; for Sevast'yanov, 120/80 mm Hg, and the pulse rates were 73 and 66 beats per minute, respiration frequency 14 and 16 per minute, respectively. The working ability of the two cosmonauts during the 16th day of the flight remained at a high level as before and they remained in good spirits.

At 1100 hours Moscow time, the next workday of Andriyan Nikolayev and Vitaliy Sevast'yanov began. During the first radio communications session, the commander of the craft reported that the cosmonauts felt well after their rest and that the crew was prepared to carry out the program of the day.

18 June /37

The crew of the Soyuz-9 had been in orbital flight for 17 days. At 1449 hours Moscow time, the craft completed 270 revolutions around the Earth. At this time, Andriyan Nikolayev and Vitaliy Sevast'yanov had spent 400 hours in space.

The next workday of the cosmonauts lasted approximately 16 hours and concluded at 0300 hours on 18 June. According to the program of the 17th day of the flight, the cosmonauts performed scientific and technical as well as medical experiments.

In accordance with the set program for the day, A. Nikolayev and V. Sevast'yanov checked out the on-board systems as their first job of the day and then had breakfast. During several revolutions, they observed and photographed the cloud cover as well as the surface of our planet: regions with characteristic local relief, the coastline of the ocean, mountain massifs.

During the radio communications sessions, the cosmonauts reported on their observations of the regions of the Pamir, Lake Baykal, the forest massifs of eastern Siberia and the coast of the Pacific Ocean.

During the workday, A. Nikolayev and V. Sevast'yanov also busied themselves with observations and photographing the moon against the background of the Earth's horizon. They studied the external surface of the illuminators in the cabin and in the orbiting section and reported in detail about their condition to Earth.

At the beginning and end of the workday, Andriyan Nikolayev and Vitaliy Sevast'yanov performed medical experiments and also checked one another's health, measuring the arterial pressure, pulse rate and respiration. According to the telemetric data and the reports of the cosmonauts, the pulse rate for Nikolayev was 76 and that for Sevast'yanov was 64 beats per minute; the respiration frequency was 16 per minute for both cosmonauts.

An analysis of the results of the medical check indicates that the men have /38
retained a high level of work ability and that the cosmonauts' health is in good condition.

The next working day of the Soyuz-9 crew began at 1100 hours Moscow time on 18 June. During the radio communications session, Andriyan Nikolayev reported that the cosmonauts felt well following their rest and that the crew was prepared to carry out the program of the 18th day.

Flight of Soyuz-9 Ends Successfully

Today, 19 June 1970, at 1459 hours Moscow time, after completing the program of a long-term flight in orbit around the Earth, the spacecraft Soyuz-9 landed in a selected area on the territory of the Soviet Union, 75 km west of the city of Karaganda.

Cosmonauts Andriyan Grigor'yevich Nikolayev and Vitaliy Evanovich Sevast'yanov feel well after their landing.

To make their landing on Earth, the craft was oriented at the proper time and the retarding motors were switched on.

After shutting off the motors, the sections of the craft separated and the section containing the crew entered a flight trajectory to Earth. The flight of the ejected compartment took place along the trajectory of the controlled launch using aerodynamic means. After braking in the atmosphere, the parachute system was deployed. The engines used for a soft landing ensured that the separated compartment made a gentle landing.

At the landing site, cosmonauts A. G. Nikolayev and V. I. Sevast'yanov /39
were warmly greeted by representatives of the search party, sport commissars, friends and newsmen.

The medical examination of the crew which was performed on the spot revealed that the cosmonauts had withstood the prolonged spaceflight well.

The prolonged orbital flight of the Soyuz-9 spacecraft was over. The crew, consisting of Hero of the Soviet Union, Pilot Cosmonaut of the USSR, Colonel A. G. Nikolayev and Candidate in the Technical Sciences V. I. Sevast'yanov have completely carried out the planned program of scientific, technical and medico-biological studies.

New Step on the Way to Orbiting Stations

On 1 June 1970, the Soyuz-9 spacecraft was launched in the Soviet Union into orbit as an artificial satellite of the Earth; its crew consisted of the commander of the craft, Hero of the Soviet Union, Pilot-Cosmonaut of the USSR, Colonel Andriyan Grigor'yevich Nikolayev and the engineer, Candidate in Technical Sciences Vitaliy Evanovich Sevast'yanov.

On 19 June 1970, at 1459 hours Moscow time, after completing the planned program for the 18-day flight, the Soyuz-9 made a landing at a selected area with great precision.

The crew of the Soyuz-9 was in orbital flight around the Earth for 424 hours. An experiment of such a duration with active participation of man under conditions of spaceflight had been done for the first time.

Numerous scientific and technical investigations, observations and experi- /40
ments were devoted to the further investigation of space around the Earth and

a determination of the possibilities of using orbiting spacecraft in the interest of many branches of the national economy.

During the flight, scientific observations and photography of individual regions of the Earth's surface that are characteristic from the geological standpoint were carried out. In particular, photographs were taken in the regions of the European part of the USSR, Kazakhstan and western Siberia. At the same time as the space experiments, photographs were taken from aircraft for purposes of geological prospecting.

During the flight, cosmonauts Nikolayev and Sevast'yanov observed and photographed various phases of the rising and setting of the Sun and Moon, cloud formations, a snow cover of the Earth, various atmospheric phenomena in order to use the data obtained in operative and long-range forecasting of weather conditions. Thus, the cosmonauts repeatedly described storm phenomena and cyclones. Reports reached the Earth from the spacecraft regarding forest fires, dust storms and storms at sea.

In the western region of the aquatorium of the Indian Ocean, a unique experiment was performed involving the photography of cloud formations in which the Soyuz-9 was joined by the scientific research vessel belonging to the Academy of Sciences of the USSR, the "Academician Shirshov" and the meteorological satellite "Meteor!"

During the flight of the Soyuz-9 spacecraft, the physical characteristics of the space surrounding the Earth were subjected to further investigation. The cosmonauts made extensive use of celestial luminaries as reference points in the development of methods and new systems of astronavigation and maneuvering. In carrying out numerous maneuvers, orientation and stabilization of the spacecraft in space, they developed the processes for correcting the spacecraft in various flight regimes. /41

The most important part of the flight was the extensive medico-biological tests to determine the effect of factors involved in prolonged spaceflight on a human organism. In this connection, special attention was devoted to measures aimed at the preservation and maintenance of good functioning state of the organism and a high level of working ability for the cosmonauts.

In the course of performing the extensive medico-biological program, the cosmonauts used various functional samples and psychophysiological tests to examine the cardiovascular system, the function of the external respiration, gas exchange and energy loss, contrast senstivity of the eyes, the function of the vestibular apparatus, the muscle-joint and pain sensitivity.

During the 18-day flight, in order to be able to diagnose possible unfavorable changes in the physiological functions of the organism, the cosmonauts carried out a constant medical check of the state of their health. The system of control employed different methods: observation of the members of the crew during their telecommunications sessions, radio conversations, reports of the cosmonauts themselves, an analysis of the experiments they performed and especially the data from telemetric information relative to the dynamics of physiological indicators.

Daily, at the beginning and end of the workday, the cosmonauts checked one another's medical condition; this involved measurement of the arterial pressures and recording of the pulse and respiration. Similar measurements were made before and after carrying out the planned program of directed physical activity. At the same time, the maintenance of normal vital activity and retention of high working ability on the part of the cosmonauts while in orbit was ensured by a rational regime of work and rest and regular nourishment.

The medical data obtained along the telemetric channels, the results of the tests performed by the members of the crew on themselves and on each other and the data from television observations of the cosmonauts indicate that they adjusted to the conditions of weightlessness in a short period of time and then withstood the complex influence of factors of prolonged spaceflight, retaining a high level of working ability throughout.

The facilities of the ground command-measurement complex and the scientific research vessels of the Academy of Sciences of the USSR, located at various parts of the aquatorium of the world's oceans, ensured a precise and continuous monitoring of the course of the flight. There was constant radio and television communication with the spacecraft, and reception and analysis of telemetric information was performed routinely.

The systems of the craft and the scientific apparatus functioned perfectly all during the multi-day flight, creating normal conditions for work and rest, close to resembling those on Earth, in the living quarters.

After completing the spaceflight, cosmonauts A. G. Nikolayev and V. I. Sevast'yanov will be subjected to careful medical observation for a short time.

The long spaceflight has ended successfully. The experimental studies performed by cosmonauts Nikolayev and Sevast'yanov are of great importance for the development of space technology and the solution of practical problems aimed at the building and functioning of long-lived orbital stations for scientific and national economic purposes.

Statement of the Crew of the Soyuz-9 at the Landing Site, Directed to the Central Committee of the CPSU, the Presidium, the Supreme Soviet of the USSR and the Council of Ministers of the USSR /43

We report that today, 19 June 1970, after completing its program, the Soyuz-9 spacecraft made a landing at a selected point in the Soviet Union. The crew of the Soyuz-9 were in orbital flight around the Earth for 18 days.

During the flight, a complex program of scientific and technical experiments was carried out, numerous medico-biological tests were performed, new apparatus and assemblies were tested in prolonged spaceflight. All of the systems of the craft worked normally. We extend our warm greetings to the Central Committee of the CPSU, the Presidium of the Supreme Soviet of the USSR and the Soviet government for the great confidence they had in us for carrying out this long flight. We feel well and are ready to carry out new tasks.

Commander of the Soyuz-9, Colonel A. G. Nikolayev,

Engineer of the Soyuz-9, Candidate in Technical Sciences, V. I. Sevast'yanov

DEDICATION

To the scientists, designers, engineers, technicians and workers, to all the collectives and organizations who took part in the preparation and successful achievement of the long flight of the Soyuz-9 spacecraft.

To the Soviet cosmonauts, comrades Andriyan Grigor'yevhic Nikolayev and Vitaliy Evanovich Sevast'yanov

Dear Comrades!

This year's jubilee, the anniversary of the birth of Lenin, has been crowned by a new significant achievement of Soviet cosmonautics. The 18-day orbital flight of the Soyuz-9 spacecraft has ended successfully. The outstanding Soviet cosmonauts, Comrades A. G. Nikolayev and V. E. Sevast'yanov have completed the longest flight in space and have carried out a large amount of scientific and technical tests and experiments. During the flight, the apparatus and systems of the spacecraft operated reliably, ensuring uninterrupted performance of all flight tasks.

An important new step has been taken in cosmonautics, marking the start of long manned space flights. The valuable medico-biological data obtained in the course of these tests regarding the influence on the organism and the working ability of man exerted by factors of spaceflights lasting many days, the prolonged and thorough testing of technical systems of the craft and the ground safety systems, the performance of an extensive program of scientific and national-economic tests and observations provide us with the necessary practical material which will form the basis of future spaceflights, bringing closer the time when permanent orbiting stations will be built.

The Central Committee of the Communist Party of the Soviet Union, the Presidium of the Supreme Soviet of the USSR and the Council of Ministers of the USSR greet you warmly, dear Comrades Andriyan Grigor'yevich Nikolayev and Vitaliy Evanovich Sevast'yanov, on carrying out the difficult and responsible tasks and on the successful completion of your spaceflight.

We congratulate all of the scientists, designers, engineers, technicians and workers, all of the collectives and all organizations that took part in the planning, launching and successful accomplishment of the long orbital flight of the Soyuz-9 manned spacecraft.

We wish you, dear comrades, further successes in your important work. Let these achievements bring new glory to our great Socialist motherland and may they serve the noble purpose of the study and conquest of the Universe by man.

Central Committee of the CPSU	Presidium of the Soviet of the USSR	Council of Ministers of the USSR

CHAPTER 2. FROM START TO FINISH /47

Bon Voyage, Falcons!

Special correspondent of *Izvestiya* Boris Konovalov reports from the Cosmodrome.

The floodlights were switched on. The rocket sparkled, like a gigantic diamond in the green setting of the gantry. Early in the morning, when the diesel locomotive pulled it to the launching pad, it was still clean, and it seemed that it could not look better. But now, in the white blinding glare from the frost that covered it after the fuel components were added, it is amazingly beautiful, white streams of vaporizing oxygen and an orange band, surrounding its well-shaped body almost at the center, add to the beauty of its "dress."

Soon we are blinded by the glare of headlights, and a bus carrying the cosmonauts drives onto the launch pad. Dressed in identical suits with their logs in their left hands, A. G. Nikolayev and V. E. Sevast'yanov proceed with firm steps to the representative of the state commission. A brief report. The answer: "Good". Now they are waving to us from the threshold of the elevator car, which will take them up where the spacecraft "Soyuz-9" is concealed beneath a shield.

Two tiny figures appear nearly at the very top. A last wave and a farewell look down at mother Earth. The next time they see it will be from space. The door of the hatch closes. Two hours to lift-off. Now their communications with Earth is only by means of radio and television. "Falcon" has appeared on the ether. This was Nikolayev's codename during the flight aboard the "Vostok." Now he has been joined by "Falcon-2."

They are different people, both in destiny and in characteristics. The /50
cosmonauts supplement one another well not only in terms of experience and knowledge. The inexcitability, calm and punctuality of Nikolayev, in the

opinion of the specialists who trained the crew for the flight, makes a successful combination when joined with the temperamental nature and rapid reactions of Sevast'yanov.

I had a chance to see them at Star City while they were training. Nikolayev is one of those people who would rather listen than talk. The information which he must acquire passes into his mind layer after layer, in the course of the conversation. Sevast'yanov is asking questions all the time. One gets the impression that he is building for himself a "model" of what is being discussed, and is always comparing and checking to see whether he has understood correctly. Sometimes the questions get to be too much, and the commanding voice of Nikolayev sounds out:

"That's enough!"

But, as they say, opposites often attract. So Nikolayev and Sevast'yanov have gradually "worn each other down," so that they have a common outlook on many things and the same reaction. This is a very good thing in flight, since in many situations the cosmonauts must act on the basis of an immediate understanding of one another.

"Return the gantry to the original position," a command states. Like the petals of some exotic flower, the gantry opens to reveal the rocket in all its splendor.

At the observation site, to which we have all retired from the launch pad, all of the conversations of "Earth" with the "ship" are clearly audible. On the television screens on the ground, one can clearly see everything that is going on in the craft. We listen as Anatoliy Filipchenko, the commander of the "Soyuz-7," who recently underwent all of the excitement of a launch himself, gives advice.

"Shove the log behind the strap," he advises Nikolayev. "Everything will be okay. Your parameters are good. You are doing great. Keep it up."

"I understand you. Everything is normal with us." /51

"To judge by the voices, everything really is in order."

Following the command of "lift-off!", weary seconds drag by slowly. Finally, however, flames shoot out from under the rocket. The ears are filled by a roar that grows to unbelievable intensity. Lifting itself above the clouds of smoke, the rocket flies into the blackness of the sky, carrying beneath it a blindingly bright flame. An enormous reddish cloud remains on the ground, penetrated by the blue rays of the floodlights.

"A slight jolt, slight vibration," we hear Nikolayev's voice. "Vibrations still low. Stresses gradually increasing."

I remember what Anatoliy Filipchenko told me about his feelings at the moment when the spacecraft separates from the final stage.

"An explosion. And you almost fall out of your chair and turn over with your face down toward the Earth, suspended on straps. The pressure against your back has simply disappeared. And the total silence, Only the ticking of your watch begins to sound oddly loud. The floodlights outside shows the fireworks caused by luminous particles."

Now Nikolayev and Sevast'yanov can see all this with their own eyes. One for the second time. The other for the first. For the first time, he is beginning to feel weightlessness under the actual conditions of spaceflight. They say that everybody who has been in the state of weightlessness can be divided into three categories; in some this creates a feeling of excitement, while others have the opposite reaction--a feeling of depression, while the third group do not notice it at all. Sevast'yanov, judging from the brief experience he has had on aircraft and his own words, apparently belongs to the first category and Nikolayev to the last.

On the eve of the launching, newsmen met with Nikolayev and Sevast'yanov. This was immediately following a meeting of the State Commission to which the crew reported at the time of takeoff. One of the newsmen asked:

"Is it true that the job of a cosmonaut may be considered an ordinary profession under extraordinary conditions?" /52

"No I don't agree with that way of putting it," replied Nikolayev. "This is still an extraordinary profession. First of all, it calls for certain physical data. Secondly, we have just begun to conquer space, and it is often necessary to go into the unknown. Of course, after awhile the job of a cosmonaut will be just as ordinary as that of a pilot is today."

Vitaliy Sevast'yanov emphasized that although the program is full and extensive, their flight will be an ordinary one, a "working" flight. In addition to purely scientific problems, they will solve problems of the use of manned flights for purpose of the national economy.

In the future, he said, scientists from highly diverse fields of specialization will be aboard the spacecraft. They will be able to carry out, for example, very interesting work in the field of geological studies, and it may be that they will even find deposits of natural resources. In particular, the study of the snow cover, which determines the level of spring floods, will be very important.

Yes, space is becoming increasingly associated with the word "labor." And it is no accident that the cosmonauts referred to their flight as a "working" flight. This is not out of modesty, but simply the heart of the matter. It should be pointed out that when you get better acquainted with the life of the cosmonauts and the life at the cosmodrome, you are struck by the lack of window dressing.

I remember how Nikolayev and Sevast'yanov parted from their friends at Star City. Simply. Like men. With a firm handshake. A slap on the back:

"Go on, now!"

At the cosmodrome, on the eve of our arrival, there had been a solemn unveiling of a memorial tablet at the home of Yuri Alekseyevich Gagarin, which is now a museum. This little three-room house, almost exactly the same as the house of Academicians Sergey Pavlovich Korolev, 20 paces distant. Two simple /53
nickel-plated beds. Gagarin slept in one on the night before the launch and Titov slept in the other. A table with a frayed cloth. A "Sakta" tube-type radio receiver.

At the museum of the cosmodrome, there are several objects which accompanied the first man to fly in space: a black tattered helmet, a large microphone, through which conversations were transmitted, a field telephone.

Recently, many "space museums" have been opened. Practical cosmonautics, although it is still developing before our eyes, already has a solid history. And it is good that these museums at the cosmodrome are small and do not put on a big show.

Here, as nowhere else, you get the definite feeling that the conquest of space is a task for large collectives of specialists. The flight of the cosmonauts only crowns their labor. The labor of scientists, designers, who worked on and built the craft and the carrier rocket, the labor of assemblymen who put together these spacecraft, the work of the individuals who subjected all of this technology to severe testing, the labor of the launchers, who ensured that the rocket and its payload would take off, the labor of many, many people. Their knowledge, inspiration, and the sleepless nights they spent all contributed to today's takeoff into the starry sky. And now they all join us in one wish: Bon Voyage, Falcon!

Dialogue Between Orbit and Earth /54

Special correspondent of *Izvestiya*, George Ostoumov, reports from the Flight Control Center.

The room belonging to the flight control group. One of the walls is made up of schematic diagrams, signal panels, television screens. The eyes of all the persons sitting in the room are fixed on one of these: it now shows the cosmonauts, who started their flight an hour and a half ago. They are completing their first revolution.

I remember the antenna dishes which I saw along the road to the command point. They were aimed at the horizon in order to "greet" Soyuz-9 as soon as possible. To pick it up as soon as it appeared from the zone of invisibility. In our sky, the sun travels from east to west, but the spacecraft traveled in the opposite direction. Just as Vladivostok receives the sun's rays earlier

than Moscow, the command point is located so that it is the first to "pick up" the radio transmission from the craft.

The television screens flickers slightly; it is ready, but the electronic clocks above it indicate that the calculated time for the appearance of the spacecraft is only a short way off.

Everyone in the hall is sitting at strictly determined positions: the control group, the ballistic group, the cosmonaut group, the medico-biological group, the analytical group. It is something like the brain: a certain portion responds to each function. Perhaps the analogy will not carry very far, but the director of the enterprise must not have to look around for the man he needs at a given moment.

Black and grey bands are running across the screen. They have disappeared. And now, like a photograph, the image of the spacecraft cabin appears before us. The television camera is aimed up at the cosmonauts.

"How do you feel?"

"Great!"

Now they exchange technical information...telemetry, which, as they say here is "dumped" from the spacecraft, confirms this--all of the physiological "parameters" of the two cosmonauts are normal, according to the levels established for this stage of the flight. Yet, now that we have gained data from flights, we can rightly speak of physiological norms for space.

Following the end of the communications session, there is a brief discussion of the operative-technical leaders. In my opinion, this calls on their maximum ability. Brief conferences of groups about which they are talking. Everyone confirms: the system or systems which are his responsibility are working normally. Then the words: "meeting over."

"Questions?" asks the chairman, and when there are none, concludes: "no questions!"

Following the meetings, establishing the pattern for carrying out the program, the chairman of the analysis group produces an analysis of the state

of the systems. Finally a member of the group entrusted with the measures which must be taken to correct deviations if there are any concludes.

Again we have an analogy with the operation of the human brain. Observations, analysis, conclusions for action. The entire meeting lasted less than 5 minutes; on the one hand, this is the result of its planned organization, on the other, the completely satisfactory situation aboard the spacecraft.

Still, the word "deviation" was mentioned once--to be sure, it was not in vain. Yes! it was noted that the carbon dioxide content of the cabin atmosphere in the craft was somewhat less than expected. What was the reason? An analysis indicated several technical and physiological reasons. Most likely, the cosmonauts were not doing all of the required physical exercises. Methods of checking this were suggested, including a conversation with the cosmonauts.

During the next communications session, the cosmonauts replied: "We can't do all the exercises. We are busy with experiments according to the program."

"Physical exercise is necessary. More important than any experiment!," the command from Earth goes forth.

"True, we are up to our ears in them," explains a medical scientist, "but the organisms of the cosmonauts must also be investigated! We have to know what effect work has on them!."

A correction is made to the orbit: the cosmonauts use the maneuvering facilities of the craft. The ballistics expert, who commented on this operation, remarked on the outstanding precision of the crew's action.

"Imagine! an error in the pulse side of no more than 0.01 second! Incredible!"

We then heard some general information about ballistics, which appeared interesting to me. We found out why the circular orbit is better than the elliptical one, we found out that by increasing the velocity by 1 meter per second at perigee the height of apogee can be raised to 3.5 km. Finally, we found that there is a minimum density of the highest layers of the atmosphere in June.

We thank the ballistics expert. She is a pleasant woman, by no means stern as we might expect from her profession, who as she said, "liked math a lot in school."

The correction was made late in the evening, and in the morning, with the room still empty, I was making some notes on my pad. Suddenly two young engineers appeared in the room.

"Yura! look, what a beautiful orbit!" said one of them.

I too looked at the panel, where a table of numbers was written. Actual data was posted side-by-side with a column of calculated values.

The parameters of the actual orbit varied insignificantly from the calculated ones. To the extent that I can understand it, Soyuz-9 will use all of the advantages of an orbit with low ellipticity. /57

To be sure, emotions do not break out here very often: everything is known and familiar. The program is enormous. There is little time aboard the ship and they are up to their ears here. Many of the experiments will take place jointly aboard the craft and on Earth.

The principal designer of the Soyuz craft says that the flight will involve purely working goals: technical and physiological problems, which must be solved before new space systems are built.

"We are looking for the best way to handle stresses in the system composed of man and machine, or rather, man and robot. This in turn will make it possible for us to determine the possibility of directed activity of man in space. We must clearly understand what must be done in order to be able to increase working ability."

We talked with the principal designer of the Soyuz craft at the beginning of the first days of the flight, and he tells us how the period of daily adaptation of the crew for the conditions in the craft ended. And everyone can see for himself who is present at the communications sessions. The voice of the cosmonauts, it seems, are noticed even by himself, is a good parameter of his general state.

3 June

"Falcon," Contact!

"'Falcon'! I am 'Dawn'! contact! do you read me!"

"I am 'Falcon'! I read you very well!"

That is how the conversation of the manned spaceflight control center and the Soyuz-9 begins. Then, when the craft passes out of the zone of "radio visibility," there is a quick meeting here at the center of the representatives of the groups of specialists. The purpose of the conversation is to discuss /58 conclusions from this revolution, determining recommendations for transmission during the next communications session.

Everybody then goes off to his workroom and areas: some of these consist of dozens of people. Another communications session, and again one or two of the groups gather in the control room. Each has its place, and each waits while the voice comes out of the "space noise:"

"' Falcon'! I am 'Dawn'! contact!"

The intervals between the communications sessions are miniature days in their own right, into which the life of the center is divided. The radio communications from Soyuz-9 are practically continuously monitored by the ground, directly from here or via other radio communications stations; in order to do this, the ship "Cosmonaut Vladimir Komarov" is drifting somewhere in the Atlantic, maintaining contact with Soyuz during the period when its revolutions take it away from the territory of our country.

There is only one other time when you can leave the main building of the center with a quiet conscience, in the sense that no interesting information will be missed; this is the time when the cosmonauts are asleep, when the Soyuz-9 craft is silent. One special aspect of the program is the fact that the period of rest comes at a time when it is daytime at the center.

The center at which the newsmen now find themselves is a concentration of powerful measuring and computing devices. Some idea of it was given to us by the directors of the appropriate complexes.

The measurements begin with calculations. A computer determines the position of the craft and trains the ground antennas on it so that the ship and the antenna do not lose each other. According to the commands of the computer, the giant conical dishes of the antennas (25 m in diameter, capable of containing a small circus with the arena and amphitheater) are aimed at the required point on the horizon.

From the antenna, the signal from the spacecraft travels along cables to /59
the receiving room. Here the "separating system" is housed. This is what that means: the radio waves carry approximately 700 to 800 types of information, so that the system divides them up and sorts them according to purpose. From this point the information flows to stations where we assume the medical, astronomical, and other types of data from the craft are accumulated.

While the antennas at the center receive a veritable flood of data from space--tens of thousands of measurements per second and many billions of signals in all (this is truly a "dumping" of information, accumulated during the time when there was no possibility of communication with the craft), following distribution to the stations there are still some quiet brooks and rivers of individual data. These streams pour into the computer to be analyzed.

The center is like a boxer or a pilot with lightening reactions; the information is immediately analyzed as fast as it is fed in. The output of the computer, working in a semiautomatic mode, follows with responses almost as soon as the data comes in.

"Does this mean that no human beings are involved?" is the first question after the explanation is over.

"No, of course not. Men have designed the programs which govern the action of the machine. They are constantly engaged in improving the program. For example, we are now feeding some heuristic blocks into the program. This means that our machine will find the solutions better, instead of using a monotonous skimming of thousands of possibilities, but will be more like a human being, which can immediately discard hundreds of unsuitable possibilities.

The director of the computer complex recalls that back when the first rockets were fired into the atmosphere, analysis of the data obtained occupied months instead of microseconds.

Ten o'clock in the morning. A meeting of the operational and technical /60
directors is in progress; the most important meeting here, studying the events of the day.

"The program is proceeding successfully. No surprises!" that is the essence of the short report. Soyuz-9 continues its work.

4 June

Day After Day

Three enormous antennas, like sentries, stand in a row at the "radio threshold of space." To a casual glance, they appear immobile. But if you focus your attention on them you can see that like saucers weighing hundreds of tons, they are moving slowly, even exquisitely, scanning the sky from horizon to horizon; they are following the flying spacecraft. Picking it up somewhere far away, thousands of kilometers from the flight control center, picking up information from it, they then "pass on" Soyuz-9 to the control of the antennas of tracking measurement points. If we consider the work performed by all the ground stations, and add those such as the vessel "Cosmonaut Vladimir Komarov," we will have a system which operates with the accuracy of the best clock mechanisms on a scale which covers the whole planet.

When you step into the semidarkness of the computer room from the spacious noisy corridor where the engineers from the different groups of the center go to exchange opinions, rest and smoke, the eye sees the fascinating twinkling of hundreds of lights on the computer panel; it is as if a fiery snowstorm were in progress there.

At the end of the computer system is a printer. A wide strip of paper almost a foot and a half wide, emerges from it, covered with lines of numbers. There is apparently no end to this "rain of numbers;" thousands, millions of /61
numbers.

Among these numbers, there are those which first raised the "problem of physical equations." I remember: the sensors detected that in the atmosphere of the cabin there was less carbon dioxide than there should be. The doctors suggested that the cosmonauts were not "exerting themselves enough" physically. The crew confirmed this, but blame the lack of time.

On the next communications session, Khrunov jestingly suggests:

"Do your exercises instead of having breakfast."

"Instead of breakfast! Nothing doing!." Nikolayev captures Khrunov's mood. "We have tremendous appetites!"

"Chew faster!"

Finally, the scientists have "tightened up" the program a little, and now the cosmonauts have 50 minutes to regulate the tone of their muscles. That is not so easy, of course.

On Earth, to put it crudely, they flapped with their arms and legs and that was all. Weightlessness in this situation "takes away" all of the stress. If bending down to touch ones toes in space doesn't involve lifting anything, how can the muscles be exercised?

Therefore, a special suit was made for exercising--but a tighter one, not a looser one. To put it precisely, elastic elements were included in the cloth which make it possible to stress the body muscles uniformly. After putting on a suit of this kind, the cosmonaut jumps, walks and runs in place, doing his exercises with an expander.

The spacecraft completes revolution after revolution. The questions passing back and forth between the center and the crew concerning problems of food are becoming less and less ("What did you eat? Did you manage to heat the food better?"), "morning" toilet ("Which way to you prefer to shave--with the electric razor or with the safety razor?") and other mundane matters. One of the "windows" in the communications session was left open to the journalists who were accredited at the control center.

Questions were passed to Nikolayev and Sevast'yanov, who replied from the spacecraft. /62

On the sixth of June, on the 66th orbit, the communications session was supplemented by a television picture. At first, the subject of physical exercise was discussed again. The doctors turned out to be an unusually scrupulous and insistent group; was complete harmony being achieved between the requirements of the program and the possibilities of the cosmonauts as far as time and effort were concerned?

"A suggestive check of the attitude here indicates that we are both in good shape, but we think that the requirements for physical exercise are very great," says Sevast'yanov. "Don't you think we could cut down a little?"

"But we are doing them completely at the moment," Nikolayev hastens to add. "We are not skipping anything on our own!" he reassures the doctors.

The second half of the session involves transmission from Earth of additional material for the study program. On the screen there are two figures bending over their ship's logs. The first dictation session in space. A spare pencil floats on a string over Nikolayev's head.

6 June

Soyuz-9 Finds Vega

Every day you see new details of the organization of the work at the center which are convenient for journalists. At one point you can always find exact information of such matters as the time and place when communications with the spacecraft will take place. The data is partly prepared by one of the computers.

Then you can see that the local radio network transmits exact time signals and 10 minutes prior to the communications session alerts everyone who is in the building about it. It summons those on duty to their places of work.

The television set has been switched on and is making noise. A bright rain appears to be falling on the screen. Suddenly broken black lines appear and both Nikolayev and Sevast'yanov show up on the screen at the same time. The big screen is switched on as well. /63

Both of them are holding their logs in their hands; they have prepared to read.

Today's report from space is somewhat surprising: they have successfully performed the experiment involving the "capture" of the star Vega. To be sure, the report has already begun and both the cosmonauts and the center are a little excited. But first of all, a few words about the significance of this experiment. Let us try to imagine an everyday situation: somebody meeting you on the street asks you to explain how to get somewhere. You mentally select landmarks along the way and explain to him as follows: "Keep to the right until you get to the clothing store on the corner, then turn right." In the language of navigators, your "clothing store" is a landmark, i.e., a feature which helps to determine his location in space. The best landmarks in astronavigation are the bright stars Sirius and Vega and the planet Jupiter.

In this case, we are talking about Vega, and about the fact that in order to orient the craft on this star then "hold" its position in space (i.e., to keep the craft flying in an orbit which will always be directed at a single point) with the aid of gyroscopes and to check each revolution how the desired orientation is being maintained.

Late on the evening of 9 June, the center heard:

"We captured the star! We did everything!" Nikolayev's voice expresses satisfaction.

We should begin by explaining that even under ideal conditions such an achievement is far from being simple. First of all, the cosmonaut must find Vega with his own eyes through the window of the spacecraft. This is complicated: he cannot see the entire celestial sphere in his field of vision, but only the part of it which is covered by the "window" of the craft. You can imagine the difficulty for yourself: find some object in your room by looking through a tube about 20 cm long and 4 or 5 cm in diameter.

The cosmonauts were moving around upside down. The solar batteries shaded the Sun, and the star was found. /64

Then the craft was oriented toward the star; the gyroscopes were switched on.

During the communications session, Nikolayev said that after the first revolution the ship was only slightly "disoriented."

Everything is in order at the center. Similar orientation is extremely important for both orbiting stations and long-term flights. Imagine, for example, that there is a telescope aboard the station. It is able to keep a certain luminary in its field of vision only if its support cannot twist or turn. The system employed aboard the Soyuz-9 makes it possible to establish a space observatory with the same kind of a reliable mount as on Earth. After reporting about the experiment with Vega, the crew dictates numbers which characterize other astronomical experiments aboard the Soyuz-9. The session is over. The image on the screen has disappeared.

"Don't forget to shut off the television camera," the ship is instructed.

"It's off, it's off! So long!"

On the morning of the tenth of June, as always, the meeting of the OTG (Operative-Technical Group) takes place. The reports confirm the following: the ability of the cosmonauts to work remains at a high level; the experiments are being performed in accordance with the program and the results are positive.

10 June

Days of Work, Hours of Rest

At the daily morning meeting of the OTG on the 10th of June, it was said that all of the experiments performed aboard the Soyuz-9 were giving positive results.

I do not know whether or not this is strictly in agreement with the report which noticeably changed the work program aboard the craft.

On the 10th of June, the program was not so full, and the cosmonauts were given a few hours off which they could devote to relaxation. The question of how to relax was answered immediately:

"Let's play chess."

"A match between space and Earth!"--there was rejoicing aboard the craft when it was decided to make some free time in the program.

The crew of the Soyuz-9 took one side and Colonel-General N. P. Kamanin and Pilot Cosmonaut V. Gorbatko made up the Earth team.

Thus, the game began on the 141st revolution. Q2-Q4, the ship's first move. The queen's gambit.

Both sides get excited easily. From time to time, there is the sound of an argument: Nikolayev and Sevast'yanov are discussing what move to make. One communications session is not enough of course. On the 144th revolution, the game ends in a draw on the 35th move.

"Thanks for a nice game," says Nikolayev.

The free hours aboard the Soyuz-9 were used for looking at "local areas," which for the craft extend over many millions of square kilometers.

"I couldn't tear myself away from Sochi," replies Sevast'yanov, when he was asked to tell about his impressions. "I saw the television tower!" the cosmonaut says of the city where his parents live.

The specialist in space medicine tells about the hours of rest.

"It is necessary in order to prevent development of fatigue. Chess is a good form of active recreation because it enables the function of the central nervous system to be toned up as well as the fact that it is an activity of a completely different nature from that which the cosmonauts have been performing for all these days."

The scientist presents some of the medical observations which have been accumulated during the past few days.

First of all: following the first three days of adaptation, all of the basic physiological indicators stabilized almost completely.

Secondly: during flight, the characteristics of reactions that were typical of the organisms of the cosmonauts under terrestrial conditions were retained in

flight. For example, while Nikolayev had a faster pulse rate on Earth than Sevast'yanov, his pulse is still higher than that of his comrade in flight.

All of the characteristics which we have observed on this flight and everything which is now taking place within the organisms of the cosmonauts holds no surprises for us. Nevertheless, this flight enables us to understand more completely the parameters of a new science--space physiology.

On the morning of the 11th of June, at the meeting of the OTG as always an evaluation of the events of the past few days was given.

"No surprises!" This is the unanimous opinion of the representatives of the operative groups. The estimate of the physiological parameters also appear to be, as they say, above all expectations.

Everyone sitting in the hall is in a good mood, as is usual for people who are handling a large and difficult task.

11 June

The Planet in the Palm of One's Hand

On the 164th revolution, the television camera of the Soyuz-9 was working, installed in the living, orbital section. The screen of the command point was filled with Sevast'yanov's face; he is making his routine report on scientific investigations performed aboard the spacecraft.

He says that the crew is engaged in developing some new devices, an /67
example of which is the navigational device for "locking on" the stars. The next group of experiments is devoted to physical and geophysical experiments. The third is the medico-biological complex, in which the cosmonauts serve both as objects and subjects of investigation. There are many problems on the purely biological plane, for example, genetic ones. The answers to these will be obtained only back on Earth, when the scientists receive the biological preparations that were launched into space.

At the command point, where these lines are being written, the tables are covered with columns of figures, i.e., those which were obtained during previous

revolutions. Beneath my pad there is a schedule of the scientific experiments aboard the spacecraft. It is marked with heavy crosses, indicating work performed. The directors of the center asked yesterday for a new schedule to be printed, showing only those tests which still remain to be performed.

Many of the tests which succeeded on the first few days will not be repeated; the results are clear and reliable!

Usually the reports from the craft are followed by questions from Earth; the comprehensive telemetry cannot tell, for example, what fitting the cosmonauts have used to buckle on the belts on which the telemetry sensors are mounted.

"The same ones as on Earth!" Nikolayev says evasively. "We haven't lost weight yet!"

"Are you sleeping outside the program?"

"No!" in a voice that is almost indignant.

"How often do you wake up? Do you get back to sleep again easily?"

"I woke up twice. Went back to sleep easily," replies Nikolayev. On another occasion, the doctors' questions seem almost naive. But the cosmonauts are patient. They understand that important scientific conclusions may hinge on some apparent trifle.

The belts which serve to hold them in their chairs were not fastened. /68
They were weaving around in the cabin like water plants in a gentle surf.

The instructions for the next revolution specified a series of photographs to be taken of the Earth's surface from the craft.

" 'Falcon-2'! There are many frames at your disposal. It would be better to take a series, several pictures one after the other."

Photography from space! Far from a novelty, but when you hear the specialists talking about the possibilities that lie before science and economics following the extensive adoption of methods of photography from orbit, you understand that here we have a situation in which literally every new step is important.

Of course we would not find any pleasure in viewing Raphael's "Sistine Madonna" if we were allowed to see at one time only a few square centimeters of the Master's canvas, and never the entire picture at once!

Approximately the same thing happens with us when we try to imagine all of the diverse faces of the planet while we are on the surface of the Earth or flying above it in an aircraft. Alas! we put together the face of the planet on the basis of small pieces and as the scientists say, often lose the global characteristics which are common to large territories.

The list of problems which space photography could solve is nearly endless: improvement of geographical charts, investigation of geological characteristics of large areas, determination of climatic zones, evaluation of the ice situation in the Arctic, the supplies of ice in the mountains. Then there could be the detection of schools of fish, determination of the composition of forests and even their infection by pests, investigation of the dynamics of ocean currents and much, much more. The specialists at the present time simply cannot estimate the economical effect--so much still remains to be investigated.

Man has literally placed his planet on the palm of his hand and is examining it. /69

On the morning of the 13th of June, the meeting of the operative-technical group is held once again, and the newsmen are making jokes about it! It seems to be the only kind of meeting at which everything proceeds without anyone looking at his watch. Everything goes rapidly, clearly and precisely!

At the meeting, among many other reports, I hear the following: the experiment in photographing characteristic portions of the Earth's surface has been performed.

13 June

Sun and Roses

Today, music has been playing in the living area of the center since morning--it's election day! As agreed in advance, people come in groups to vote in order not to lose any time. The cosmonauts who are working on communications with Soyuz-9 are supposed to show up at the voting place at 8:30 in the morning

according to schedule. Large vases of roses stand before the ballot box. It is now quiet at the command point of the center. There are no communications; the Soyuz-9 crew is asleep. Asleep on schedule.

It is also quiet all over the area surrounding the center buildings; ordinary work has come to a halt. Instead of the hissing of the welding torches or the distant roar of a tractor, the twittering of birds floats in the open windows. Those on duty converse softly as the shift changes; in front of the tables on which the graphs and charts for the coming day are posted. A vase with two crimson roses stands on the desk of the command point.

Here is a generous Earth and a generous Sun. It has been getting increasingly strong in days past. Each report from the representative of the group which ensures the radiation safety of the flight, who now participates in the morning conferences, receives more attention. Everyone knows that there is no direct relationship between the weather and solar activity, but nevertheless they think: it is hotter here and more dangerous there...

I converse with a scientist--a member of the radiation safety group. The /70
task of this group is to predict solar activity during the flight, to check the possible level of irradiation of the crew from solar flares, and finally, if danger arises, to protect the crew by whatever means science can provide for this purpose.

Oribtal flights, says the scientist, are somewhat simpler in this regard. The orbit of the Soyuz-9 passes below the radiation belts of the Earth and their radiation has practically no influence on the craft. In addition, the geomagnetic field is effective to a certain degree in preventing the penetration of charged particles into the area where the orbit of the craft lies.

The forecast indicated low solar activity during the initial period of the flight, followed by a slight increase in its level. So it is proving to be. There have been solar flares during this time, but they did not produce any significant changes in the radiation situation in the orbit. The Sun is under constant observation as is its activity. The observations involve astrophysical stations and geophysical observatories. Aside from all this, there are sensors

in the compartment of the craft itself. We get their readings by telemetry. The data from all of these services reach the center immediately. They are analyzed by our group and the results are issued each morning. So far, everything is going fine.

"For the sake of clarity, could you compare the situation with something that everybody knows?"

"I would put it this way: the radiation levels in the compartments of the spacecraft during flight are several times less than the dose which a patient in the hospital receives when his chest is x-rayed."

"Tell me please, what sort of specialist do you consider yourself to be? How should I refer to you in the interview? Physicist? Biologist?"

"One word won't do," smiles my subject. "I am, as they say, at the /71
"junction" of several sciences; I am a physicist, a biologist, a doctor,..."

Communications session for the 189th revolution. It is still daylight, and so the session proceeds without television accompaniment. There is an exchange of technical data between the spacecraft and the center. There are a few words about soccer in Mexico.

A new communications session approaches. A fantastic garden blooms around the buildings of the center: the antennas raise their heads like gigantic metal flowers, but they are not capturing the sunlight; they are picking up thoughts transmitted from space!

14 June

Three Hundred Revolutions

On the 15th of June at 2200 hours, the second week was passed. It was the fourteenth day of the flight of the Soyuz-9 spacecraft. A new mood could be sensed at the center. New because the daily successes in the performance of the program since the very beginning of this long space experiment had created a high psychological background here.

I recall the first talk with newsmen held by the chief designer of the Soyuz craft. He said at that time that on a long flight it is necessary to investigate the behavior of the human organism, and to study all aspects of the "man-machine" system under conditions of spaceflight and under its prolonged influence. In this connection, it is necessary to mention an experiment in which the problem was posed of determining the working ability of man when carrying out complex and precise experiments. They talked about a series of investigations in which a cybernetic device would be used. Of course, the account was not the kind that would allow us to go into the details of the complex electronic circuit.

The purpose of the experiment is more important for us. Long before the flight, the cosmonauts worked out specific operations on this cybernetic device. Now they are performing the same operations in space. A comparison of the results (in which the machine itself took part)--on the Earth and in space---makes it possible to draw the necessary conclusions regarding the operation of the "man-machine" system following a prolonged stay in the craft as it orbits. /72

The 189th revolution was devoted to a meteorological experiment. It was extensively and carefully planned. The experiment involved not only the Soyuz-9 but also the scientific-research vessel of the Academy of Sciences of the USSR "Academician Shirshov" and the meteorological satellite "Meteor," flying at an altitude of approximately 630 km. This was in the western part of the aquatorium of the Indian Ocean. When Soyuz-9 "captured" the ship floating in the ocean, it took a series of photographs of the cloud cover, while a second series of pictures was taken above the ship itself and a third ahead of the "Academician Shirshov." At the same time, radiosondes were launched from the ship, which performed a vertical "cross-sectioning" of the atmosphere, determining its characteristics. At the same time, this same region was scanned by the television cameras aboard the "Meteor" satellite.

A comparison of the photographs taken from the Soyuz-9 with the television pictures which were transmitted by the Meteor and the readings from the radiosonde will be of great interest to meteorologists. This kind of experiment

makes possible a complex study of atmospheric phenomena and is important for improving weather forecasting.

It is easy to pick out the medical men, among all the specialists who are presently here at the center: they are at the center of attention. For all the other scientists, experiments start and end, but the medical experiments really continues around the clock throughout the flight. The medics' findings are /73
very optimistic: at all stages of the flight, the mood of the crew and its working ability can only be sources of satisfaction to the specialists.

15 June

The View from the Heights

It is many days now since the communications sessions took on a remarkably routine and nearly technical nature. To be sure, there is not an entire globe circling trip in space between these sessions, but an ordinary aircraft route, from Moscow to Kiev or Novosibirsk. Before reporting their scientific data, Nikolayev or Sevast'yanov frequently add: "I saw a dust storm," or "we saw the bright traces of meteorites in the atmosphere." But this is spoken in a quiet and even voice, as if they were completely anticipated reports.

The newsmen at the center have had to acquaint themselves recently with the possibilities opened up by photography from space.

We learn about this from the scientist who is in charge here at the center of the operation group for scientific research. A very reserved individual, he nevertheless tells us facts which truly could make anyone an enthusiast of space geology and space prospecting.

"What are the purposes of these experiments?"

"We want to determine the optimum, the best conditions for photography for the needs of geology. For example, what time of year is best suited for this: autumn? winter? summer? We have to have a lot of space photographs in order to work out the means of interpreting the photographs, i.e., understanding what appears in the pictures and how to interpret certain details from the geological standpoint.

Therefore, we have relied primarily on aerial photography: comparison of photographs taken from the air and from space will promote a better understanding of both. Of course, when photographic charts are ready, they will (we hope) serve the practical needs of geological prospecting.

"What features in the photographs are of the greatest interest to geologists? Give us an example!"

"We are currently working out methods of so-called planetary geology. This deals with the globe as a body which is made up of enormous pieces, moving relative to one another to some degree. So we say that it studies the laws of the movement of continents. This of course is a very rough idea of this trend in modern geology.

"To be sure, the discoveries concerning the role of so-called fractures is particularly interesting. They can be compared roughly to "cracks" in the continent. There are many indications that the fractures correspond to outcroppings of many valuable natural resources. There are examples of other interpretations of fractures.

Let's say that a group of swamps were drained in Byelorussia and to everybody's surprise some meadows that were 150 km away from these swamps began to dry up too! Later, when the geology of those areas was studied, it was found that the meadows and the swamp lay on the same fracture and the swamp water traveled to the meadows underground. Fractures extend for thousands of kilometers. For example, from the standpoint of planetary geology, Lake Baykal, the lakes of northern Mongolia, the Caspian and Black Seas are all part of a single super-gigantic fracture. We could talk at greater length about the significance of fractures. But here is something else that is important--they are very difficult to detect on the surface and from the air. But they show up clearly in the photographs taken in space!"

At one of the evening sessions, when the geological experiment was over, /75
the center transmitted one of its usual questions:

"How do you feel?"

The crew responded rather boisterously, apparently because the flight had already exceeded all of the limits known to the cosmonauts.

"We feel great! 'Falcon-2' too," Nikolayev added loudly and with enthusiasm. "We are as used to it as if we had been living like this for centuries. If we didn't have the windows, it would be the same as in the training facilities. We sit in the trainer and talk with you. We are busy with our sports, doing our exercises. We are in a very good mood and are completely at home."

Nikolayev is clearly excited. They understand him here. Everybody on the shift smiles.

16 June

Sunrise is Prettier than Sunset!

On the 16th of June, there was a little more time for relaxation aboard the Soyuz-9 than usual: the program had become a little less strenuous since it was not necessary to repeat experiments that had been completely successful.previously. Only one study is not being interrupted and will be completed much later than this long flight will last. We are talking about the study of the state of the organisms of the cosmonauts themselves under conditions of orbital flight. They are practically under continuous monitoring. The telemetry system is conveying information to the center regarding all of the most important functions of the organism.

We listen to the account of the director of the medical control group, who is trying to find some way to describe the state of the two cosmonauts after 16 days in flight. "The physiological parameters are very good!" /76

"Adaptation is also outstanding, the reactions of both cosmonauts, beginning with the fourth day, have long since returned to the normal level, characteristic for conditions of spaceflight, and now have stabilized completely."

"All of the functions which we are monitoring are normal. The electrocardiograms are also exactly the same as on Earth."

"What changes have you noticed?"

"Such generalized indicators as the pulse frequency have changed; it is lower. This is readily understandable; the muscle stress is less under conditions of weightlessness and the weight of the blood itself has vanished and this means

that the flow of stimuli is different. Hence, there is less stimulation of the central nervous system which in turn also governs the rhythm of cardiac activity. There have also been changes in other functions, but all of these changes must be viewed as a new equilibrium between the conditions of the medium and the organism. In other words, we are dealing with space physiology which has its own norms."

"We are very glad," the scientist continues, "that we are not just dealing with a man in a spacecraft cabin, whose condition could be compared with someone lying in a clinic during examination. No! both cosmonauts have led very active lives, carrying out an extensive program of complex tasks. Therefore, we can say that space physiology and medicine are obtaining additional important data regarding the state of man in such flight.

"The state of health and working ability of the Soyuz-9 crew remains at a sufficiently high level. This flight will make it possible to solve the problem of weightlessness more sensibly."

Then the conversation turns to modern methods of medical monitoring during flight. "It would be scarcely possible to record all of the parameters of the organism," the scientist says. "And this is not necessary. It is more important to establish the general nature of the changes that occur during weightlessness and to identify the characteristic signs which will allow us to diagnose the state of man. We can say that the medical monitoring is not permanent, even in space. When we are studying all of the aspects of the changes, as is done for example in connection with pilots, the need for constant monitoring may disappear. /77

"On the way to achieving this, it is necessary to have a strict order of procedure, a responsible approach to each new step in the investigation. Not everybody remembers, for example, the long flight of the "Cosmos-110," which carried the dogs Veterok and Ugolek. The animals were in a state of weightlessness for 22 days and after they returned unharmed it was found that living organisms can spend a long period of time in orbit."

On the 17th of June, the cosmonauts proceeded as usual: scientific experiments, physical exercises, medical checkups (aside from that reported by

telemetry). At 0300 hours their evening ended. Now, on the morning of the 18th, as these lines are being written, the crew is asleep.

Life aboard the spacecraft has "settled down" as in an old house, where generations have lived. Startling news gets more and more scarce.

The crew took our soccer loss very much to heart.

- The cosmonauts always get very excited when they talk about how good the Earth is! For the meteorologists Nikolayev painted a "portrait in words" of the cloud cover above the southern part of our country. The craft at this time was traveling on the morning side. Suddenly we heard:

"Sunrise is prettier than sunset!"

13 June

Good Morning Falcons! /78

Sixteen days of the flight of the Soyuz-9 have passed. There are no changes aboard the craft: as always there is work, medical checkups, physical exercise and rest. At the control center, life goes on in similar daily cycles.

Each day, the operational-technical group for the flight accept the reports of the groups in which the first steps of the work of the Soyuz-9 crew were performed and the state of the systems of the craft. If we sum up all of the technical reports submitted to the group, the results will be simple, clear and optimistic: the condition of the spacecraft and all of its systems does not preclude continuing the flight. The crew, in the opinion of the physicians, is in outstanding condition: both in regard to their health and their ability to work.

During weightlessness, the blood fills the vessels more uniformly and this means that in the upper half of the body, in comparison to the normal situation on Earth, there is an excess of blood. This explains the sensation of blood rushing to the head which remained with the cosmonauts until the end of the first day of the flight. During this initial period, the adjustment of physiological functions to weightlessness included retention of the terrestrial standard rhythm for cardiac activity. On the fourth day of the flight, the pulse rate settled at a relatively constant level, lower than on Earth. This is also

understandable. Weightlessness primarily results in a reduction of the demands placed on muscular exertion. The closed volume and the reduced flow of external stimuli directly or indirectly leads to a drop in the pulse rate.

Later, in the report of the medico-biological group, mention is made of the fact that numerous functional tests did not show any kind of deviations in the physiology of the cosmonauts. More precisely, their systems were in a new and stable state, quite different from that on Earth. They had achieved a special, cosmic standard of vital activity. /79

The large table specially prepared for this meeting showed the way in which the program of scientific experiments was being carried out.

The reports were frequently quite laconic.

"No changes in the operation of the automatic devices! Report complete!." That is a word-for-word transcription of everything that the representatives of the group responsible for the operation of these types of devices said. Equally brief were the reports of the command-measurement complex, the ground communication group, the group responsible for telemetry analysis and others.

The conclusion was unanimous: the program was being performed well.

June 18th, 1000 hours. The cosmonauts, in accordance with the program, are asleep. Since 0300, the communications sessions with the spacecraft have been limited to reception of telemetry; this protects the sleep of two brave people. The meeting of the operations-technical group begins. The steps taken during the past days are evaluated; everything is in order, everything is normal. The order of events for the next day is confirmed.

Soon 'Dawn' says:

"Good morning, Falcons! Shall we start work?"

18 June

Back on Earth

"I see the craft on its parachute!" the faraway happy cry of the pilot is first heard by the radio operation at "Dawn." The details are received in a minute: the craft was first spotted by the crew of a "MI-8" helicopter, which was commanded by pilot Zhulyabin.

"The parachute has almost reached the Earth!" a grey haired engineer tells me, a member of the State Commission. Still 15 minutes away from a soft landing.

"Aboard the Soyuz-9 they are saying 'I see the airplane to the right!' " /80 says the operator.

"The craft has made a soft landing," the operator finally passes on the word from the pilot, the commander of the helicopter, Shlopak. An then:

"The crew is reporting as follows: landing normal, condition normal!"

I remember how three hours ago at the next to last communications session, the crew received an order from Earth:

"After landing, you must report your condition twice. Twice! Have you got that?"

Our operator also repeats excitedly:

"Condition good! Condition good!"

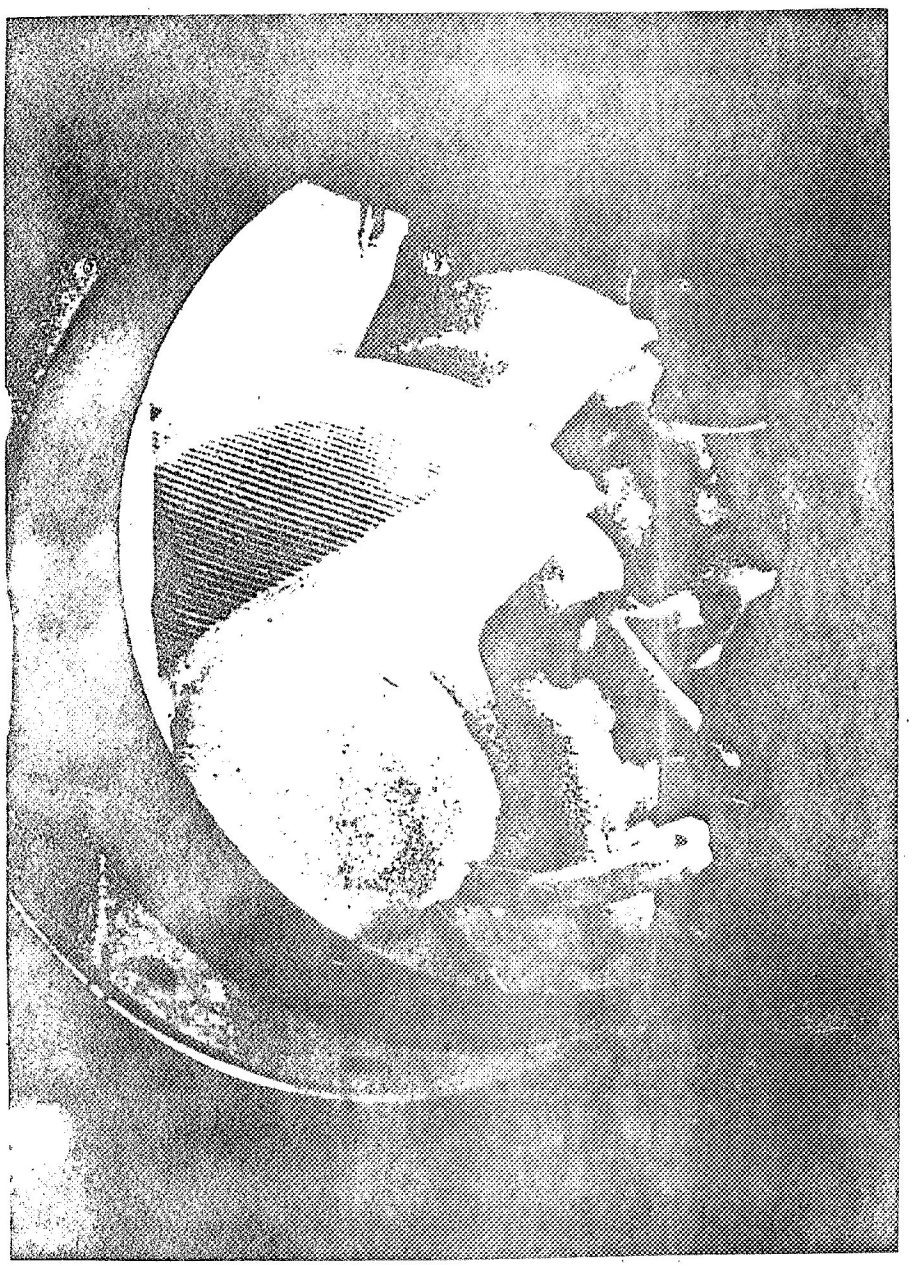
"Fifteen ten hours," the operator continues. "The longest spaceflight is over! The crew is getting out of the craft."

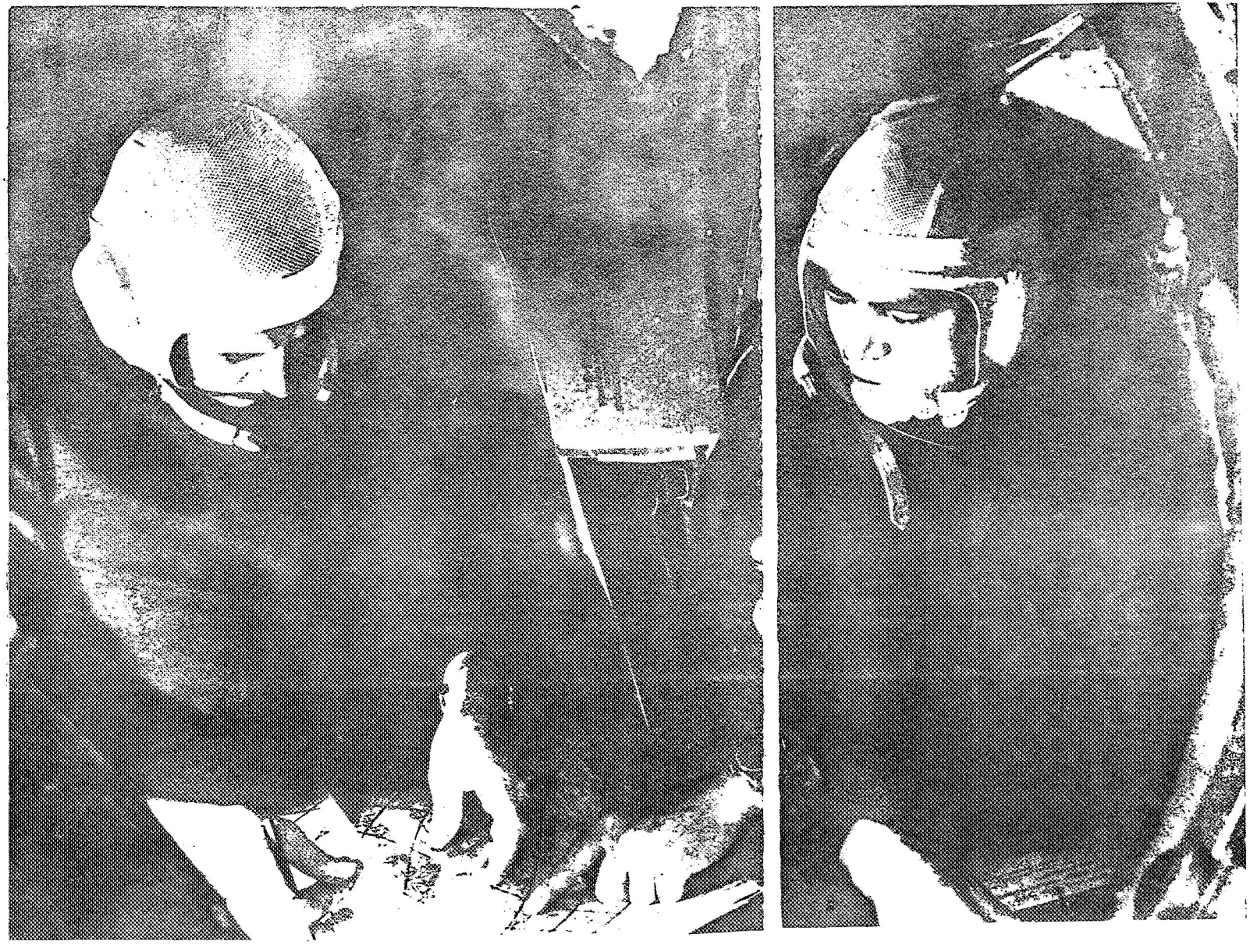
The great hall of the flight control center cannot restrain its applause.

A while ago the Soyuz-9 was flying in profound darkness. The starry sky above and below what seems to be black velvet; that is the Pacific Ocean down there.

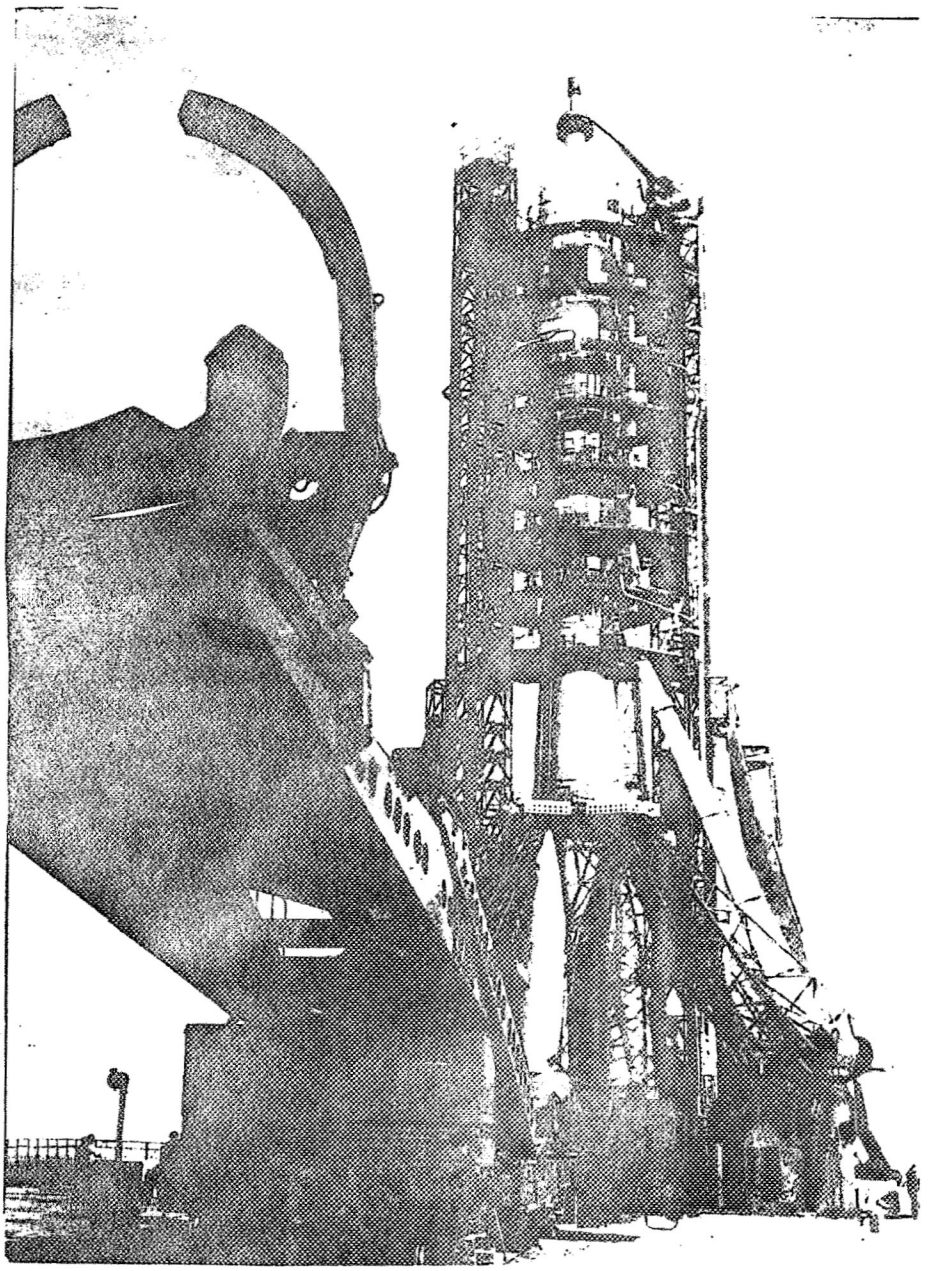
The ship is already prepared: the nozzle of its braking motor is pointing straight ahead.

At the very tip of South America they emerge from the shadow. The cosmonauts see the morning glow over the planet for the last time on this flight. Ahead lies the day at whose end they will be on Earth.



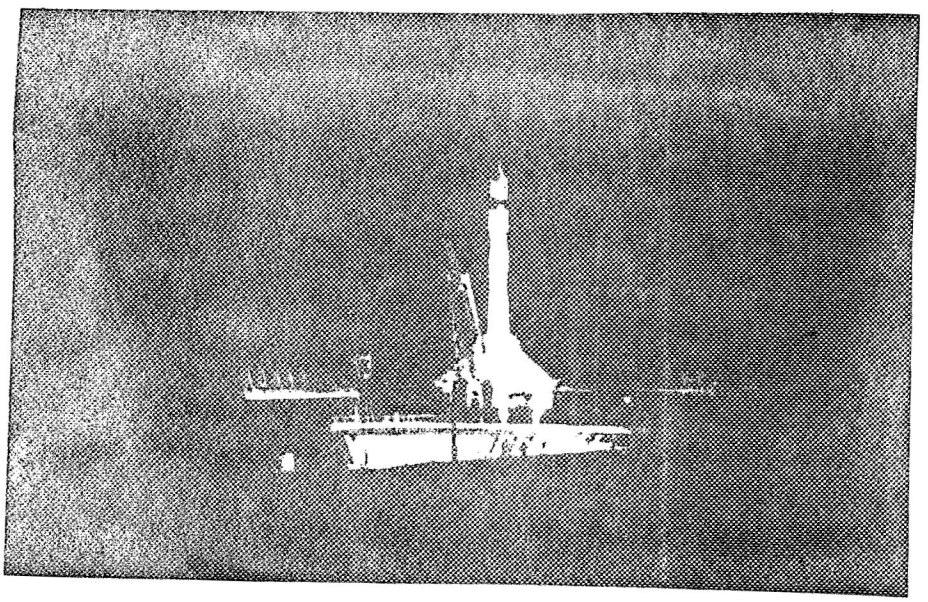


Long Before the Flight, the Space Twins Began to Familiarize Themselves with the Cabin of the Spacecraft.

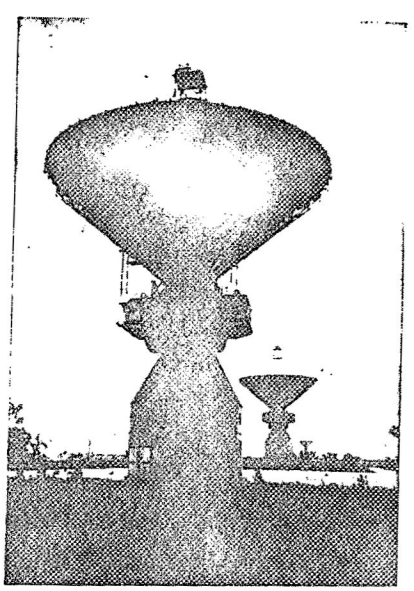


Soon the Launching Will Take Place.

Cosmodrome. 1 June 1970. The Crew of the Soyuz-9 Spacecraft Reports: "Ready for Takeoff!"

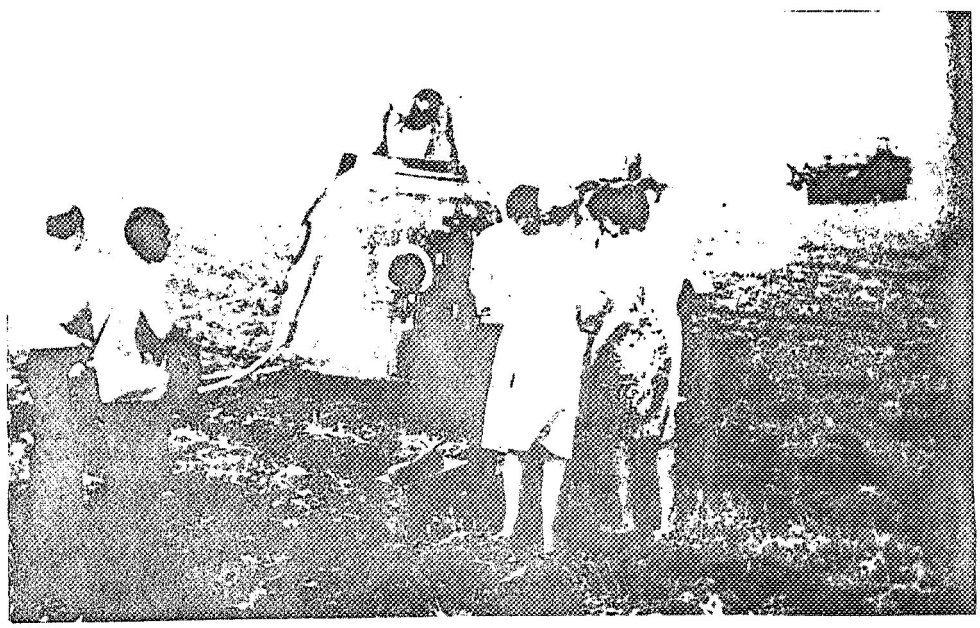


One Minute More and the Blinding Light of the Fiery Streams Issuing from the Mighty Engines of the Rocket will Light Up the Launching Pad. Soyuz-9 will begin its long flight.



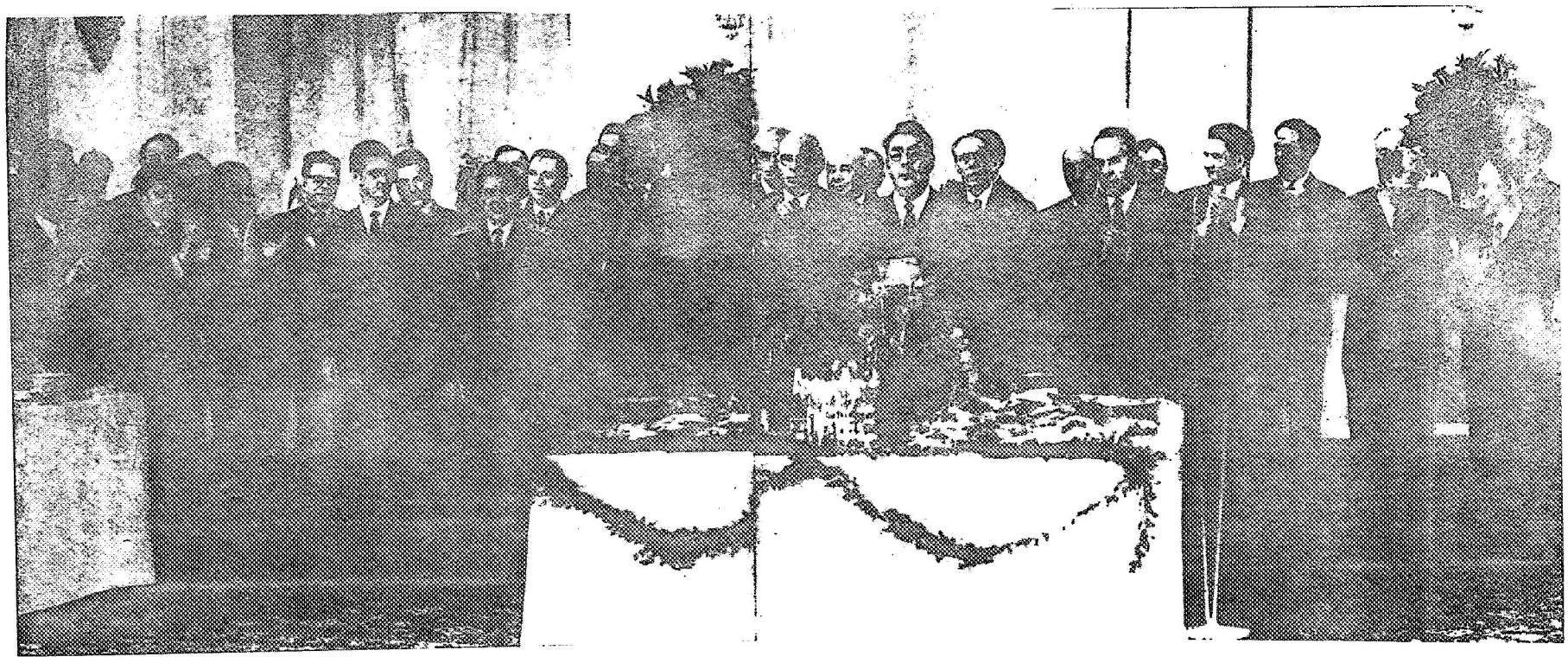
The Enormous Antennas of the Flight Control Center Ensured Reliable Communication with the Soyuz-9 Spacecraft.

"Papa! Do you hear me?"
"I hear you," Comes the Voice of Andriyan Nikolayev from Orbit, Congratulating His Daughter on Her Birthday.

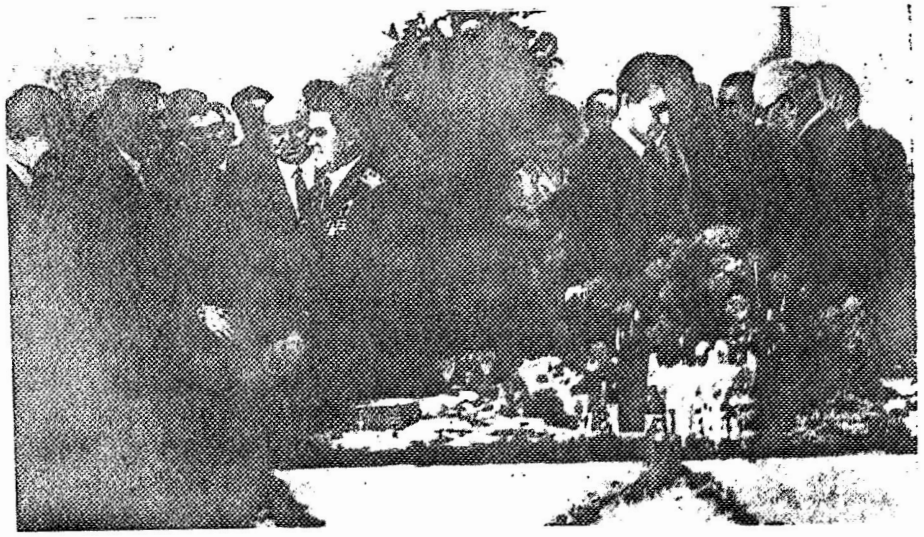


The Soyuz-9 Has Just Landed. Now they are opening the hatch and the cosmonauts will leave the vehicle in which they have spent 18 days.

Greetings, Friends! Cosmonauts Andriyan Nikolayev and Vitaliy Sevast'yanov climb down the stairs from the aircraft to the tarmac of the Moscow Airport.



Moscow, 3 July. During the Reception at the Grand Kremlin Palace.



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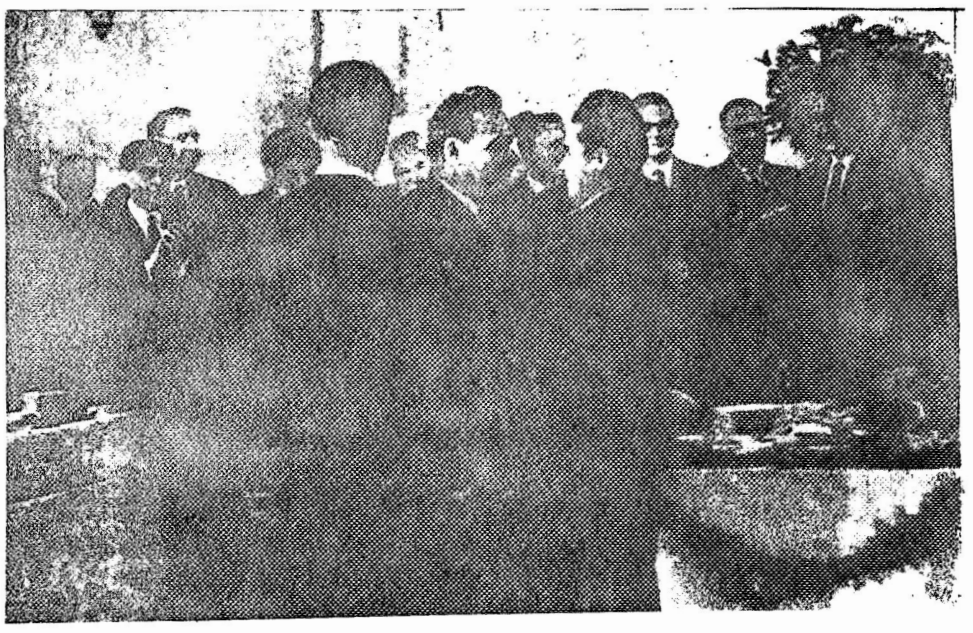

"According to the calculations, the braking engine begins to operate when the craft crosses the Atlantic Ocean, somewhere over the Guinea Trench. If it had been the time of Columbus, it would have taken months to travel from Tierra del Fuego to Africa. In the 20th Century, the cosmonauts need all of 15 minutes to wait until they begin their approach to Earth.

"Here, at the command point of the center, with the numbers and the charts posted, indicating information that has not been needed beforehand--a map of the Earth on which the end of the last and 287th revolution is marked. It rests on the Earth somewhere in the vicinity of Karaganda.

Everybody who is here looks at the place where the line of the orbit is marked with a red pencil: the area where the engine is switched on. Did they start to brake on time?

Here, accuracy is more important than at the time of launching. Braking the craft too late or too early will cause it to come down where no one is waiting for it! Everybody looks from the charts to the electronic clock. Oh, how slowly the flickering numbers count off the seconds!

The speed of the craft must be slowed to 95/m/sec--no more and no less. Otherwise they will land somewhere other than the planned location.

"The engine operated for the required time!" This comes in a radio report from a ship sailing in the faraway Guinea Trench, in the zone of direct radio visibility of Soyuz-9. Fareweli, orbit! The craft has begun to slide downhill--that is exactly how the plot of its trajectory looks. It is an enormous hill--one-fourth of the Earth's equator from start to finish.

Braking is very important, but the same is true on Earth!

Now the entire mass of the ship is rushing earthward together with the instrument and orbital sections. The cosmonauts are seated in the part that will be separated; all the rest must be discarded, shot away, so that only the most precious part will have to fly into the fiery embrace of the atmosphere.

"Separation complete," reports the operator, following the telemetry.

"Good--but they are not on Earth yet!"

Several minutes later the command point is empty.

I am writing these lines in the "pink" room of the center. Behind me there is noise and bustle; the television cameras which have been rolled in to record the last meeting of the State Commission cannot get through the door.

19 June

Soft Landing /82

Report from the Landing Site

We spotted the cosmonauts at the dinner table. They smiled happily at our greeting.

The first and unavoidable question was: "How do you feel?"

"Great!"

"Bon Appetit!"

"Thank you. We missed our terrestrial diet," says Sevast'yanov.

The dishes before them are full. Caraway rye, tomatoes, radishes, onions, cucumbers, chicken, bottles of mineral water.

We could not talk very long with the cosmonauts. They are being guarded carefully. This is understandable: they have just been in space longer than anyone before them--424 hours. Their organisms might now be susceptible to any infections which would be absolutely harmless for you and me.

In the morning, on the day when they landed, the journalists met with one of the directors of the medical program for the Soyuz-9 flight.

"It is a rare thing when mistakes are the occasion for joy," he noted. "But this time it is true. Our predictions were not justified: the cosmonauts felt much better during the flight than we expected."

The first three or four hours of the flight is the period when the cosmonaut becomes a real cosmonaut. It is precisely at this time that the human organism

adapts itself to the flight conditions under weightlessness. This was very successfully described by G. Beregovoy:

"Time seemed to slow down for me, I felt that I had to do something, but time seemed to become sort of sticky and viscous." Actually, this is not a slowing down time but an increase in the processes of movement in the course of one's first encounter with weightlessness. This is only one aspect of the process of accommodation which lasts three to four days. Then one seems to get one's second breath. He waits with some excitement to find out when the limit of the known will be exceeded. The duration of the previous longest flight was 14 days. However, nothing special happened. This was clear to millions of television viewers who watched regular transmissions from space. But how do cosmonauts survive a landing on earth after such a long stay in the state of weightlessness, and how do they handle the return to terrestrial conditions? How do they feel?

These problems excited everyone. On motorcycles and in automobiles, people streamed to the landing site of the "Soyuz-9". The descending craft was clearly visible, and an aircraft with a group of observers was able to make several circles around it. Helicopters were there too. For an instant it seemed that the craft was going to land in the swamp, then in the hills. But it came down right in the middle of a clear, soft field. Literally several seconds later, the helicopter set down next to the ship.

"When we came up to the ship," a medic told us, with whom we spoke that morning, "dust was settling slowly which had been thrown up by the landing." Through the window we could see children. They were smiling. The hatch opened and Andriyan Nikolayev appeared. We congratulated him on the successful completion of the flight.

A little while later, A. Nikolayev began to hand over the scientific apparatus to the engineers. We remembered the story of the sport commissar I. G. Borisenko about the first landing of Nikolayev in this same place, on the soil of Karaganda, aboard the "Vostok-3". He was then one of the first to reach Nikolayev. He looked in and saw him sitting and transmitting messages on the radio about his landing.

"Here we are. The helicopters are landing already," we cried out to him. /84

"The schedule calls for me to make a report..."

He finished and put away the set. Only after this did he embrace us.

Now he was carrying out the program according to orders once again. The medics had already told us previously that A. Nikolayev and V. Sevast'yanov were completely different in their nature and temperament. Although division of people into psychological types is a very arbitrary procedure, roughly speaking, Nikolayev is more melancholic and Sevast'yanov is more sanguine. It was interesting to see how people of different psychological types returned to ordinary terrestrial conditions following a long stay in space.

Their first feelings after landing were about the same. Both said that their sensations resembled the condition of sailors going ashore after a long voyage. After a little while, however, the temperamental V. Sevast'yanov asserted that he was now ready to dance a waltz.

They often referred to their flight on those days as work. The results of this flight are important for meteorologists, cartographers, geologists, medical personnel and many other representatives of purely national economic organizations. In addition, the flight of the "Soyuz-9" was one of research. The tasks of the cosmonauts in future will be to build orbiting stations, flying institutes where scientists working in different fields will have their laboratories. And it is very important to know in advance how man is affected by a long stay in space.

Andriyan Nikolayev spent 95 hours in space during his first flight. Now, together with Sevast'yanov, he had set a new record for flight duration.

One of the designers of the "Soyuz-9", when we entered the dining room to leave the cosmonauts to rest told us that the skilled actions today of A. Nikolayev and V. Sevast'yanov in controlling the landing provided a great deal of valuable information regarding the working ability of man returning to Earth following a long stay in orbit. The doctors were also interested in something else: the time during which the cosmonauts returned to their former condition and are ready to undertake a new flight. /85

"I think that the engineers will not be angry with me. For them, their work ends at the moment of landing, but for us the period of tension continues," one of the medical men said to us. "We are going to make very careful observations of the cosmonauts' condition."

After a rest in Karaganda, the cosmonauts flew to Moscow. The space portion of the flight was over but the one on Earth continues.

Karaganda, 20 June
A. Yershov, B. Konovalov,
Special Correspondents of
Izvestiya

Greetings, Friends! /86

One of the airports in the Moscow suburbs. 10 o'clock in the morning. On the concrete runway, two workers are carefully rolling out a red carpet: This is where the wheels of the airplane carrying the heroes will stop. This is not only for the sake of order, it is a convenient way to keep back the movie and television crews and everybody else who has come to greet Nikolayev and Sevast'yanov. There are many greeters -- all of the directors of the flight, scientists, doctors, fellow cosmonauts.

People who were over their heads in work for all those days apparently have thrown off fatigue for one night. Jokes, laughter -- there is no need to describe the mood of the crowd gathered to welcome the cosmonauts. The newsmen finally succeed in getting an interview with the chief designer of the "Soyuz" spacecraft and a representative of the State Commission.

"What is the principal conclusion from the fact that this was such a long flight?"

"There was serious discussions as to whether it was safe to fly in space for more than two weeks without any unpleasant consequences. Now we know that man can not only fly but more important -- work for longer periods of time. It is clear that in the future there will be space flights that last for months, years and more. But we must understand what we must do, what conditions must be created in the spacecraft in order to help man to retain his working ability at the required level. Now we are reaching the conclusion that no extreme measures will be required. It is still necessary however to know some of the results of the final analysis of all the scientific materials accumulated by telemetry and noted by the cosmonauts in the craft.

"More than enough to write several PhD theses!" smiles the chief designer of the Soyus spacecraft.

"Many of the experiments performed on the Soyuz-9 appear to apply to prospects for considerable importance of orbital flights for the national economy. Is this true?" /87

"Unquestionably yes. We are already deluged by requests from meteorologists, geodesists, geologists, who want to solve their problems from sapce," replies the chief designer of the Soyuz spacecraft. "We can understand that: space methods provide data that are unavailable by other methods. For example, even while the flight was in progress, scientists working on seismic phenomena approached us with a request to photograph an area in Kirghizia, that is highly subject to earthquakes. During the last few hours of the flight of Soyuz-9, photographs were taken of Lake Issyk Kul' and the mountains surrounding it."

"What would you say about the technology involved in the flight?"

"It worked continuously all during the experiment, and there were no failures, as we said. Some people", the chief designer of the Soyuz spacecraft glanced slyly at one of his colleagues, "complained that it was even boring: there were no surprises and no problems with the technology. I'm talking about the analysis group. They really didn't have to go looking for trouble.

The craft in the Soyuz series have shown themselves to be capable of solving a wide range of problems. They participated in experiments in docking, and the transfer of cosmonauts from one ship to another. The Soyuz craft have rendezvoused in space, maneuvered, landed under a controlled regime and have a high accuracy in landing! I must say that like all the cosmonauts, the commander of the Soyuz-9 and the flight engineer were well prepared for the flight and were able to make full use of the possibilities of technology!

The representative of the State Commission, in turn, gives high marks to the work of all of the many services and groups who made the flight possible. Together with the chief designer of the Soyuz spacecraft, he asks that the greatest thanks be extended through the newspaper to all those who took part in the many stages of the experiment, beginning with the launching and ending with the reunion on Earth.

"What lies before cosmonauts Nikolayev and Sevast'yanov after we leave them here?" -- A question for the representative of the State Commission.

"Careful medical and biological examination. Scientists must obtain the detailed picture of all of the changes in the physiology which might have been produced by this long flight. There will also be important observations of how vital functions return to terrestrial norms.

It will be best to do this under conditions when the cosmonauts are isolated from the "noise" of ordinary life on Earth. The State Commission has agreed with the suggestion of the doctors and immediately after their arrival in Moscow Nikolayev and Sevast'yanov will spend several days in a special apartment where the necessary isolation will be ensured. Of course, newsmen will be able to see them and talk with them."

The aircraft has stopped at the markings provided on the runway. One minute more and the cosmonauts are on the top of the staircase! They are smiling. They look great!

G. Ostrumov, Special Correspondent
of Izvestiya

20 June

Yekaterina Sheveleva

The Exploit

I was not able to fly into space
What honor for those who were chosen!
But such a force can be nourished in everyone,
To light a fire, to cure ailments,
The great news about the achievement.
And to give wings to everyone,
More stoicism and trouble,
More creativity and joy
In ordinary everyday labor.
A soul full of high ideas beneath the canopy of star ships.
I am simply a woman and I go with confidence over the blue Earth.

CHAPTER 3. LONG-TERM EXPERIMENT IN ORBIT

/91

Long Experiment in Orbit

The Trip Aboard the Soyuz-9 Spacecraft

The development and construction of piloted spacecraft in the Soyuz series were based on all the preceding developments in Soviet space science and technology and ensured by the high level of our industry. The Soyuz spacecraft are better than their predecessors -- the spacecraft in Vostok and Voskhod series. They made it possible to carry out various scientific studies, experiments and observations in space. They make it possible to study our planet from all sides as well as its atmosphere, to study the conditions in space around the Earth, to perform observations of the Sun, stars, planets, etc. outside the atmosphere.

The Soyuz spacecraft differs from the Vostok and Voskhod not only in that it has much larger dimensions, but there are new design features for the systems of the craft. All of this enables the cosmonauts to carry out various maneuvers including approach, rendezvous and docking. The systems and equipment aboard the craft allow it to descend smoothly to Earth with considerable precision.

How is the Soyuz spacecraft constructed, and what are its basic structural features?

The craft consists of three main sections: the landing apparatus, the orbital section and the instrument section.

The landing apparatus (cosmonauts' cabin) is intended for housing the crew when the craft enters orbit, for maneuvering in orbit and landing on Earth. It is located in the central part of the craft. The housing of the landing section is hermetically sealed. A thick layer of a special heat proof covering protects it against aerodynamic heating when landing on Earth.

The landing section contains the cosmonauts' chairs. They are made precisely to fit the body of each cosmonaut, and they make it possible to easily withstand even considerable overloads when they arise under special conditions. /94

Inside the cabin is the apparatus for controlling the landing, radio equipment and life support systems. The parachute system is contained in a special container. The housing carries jet engines for the landing control system and the engines for a soft landing. Directly ahead of the commander of the craft is the control panel of the ship, on which devices for monitoring the operation of systems and elements of the ship are mounted, navigation equipment, a television screen and switches for controlling the onboard systems.

There are three windows in the body of the capsule. One of them is lined up with the control panel. An optical sight and guide are mounted on this window. The other two windows are located on the left and right sides of the craft. They are intended for visual observations, the taking of motion pictures and photographs.

Normal atmospheric pressure is maintained in the capsule all during the flight; the humidity and air temperature also remain normal. The microclimate of the craft enables the crew to wear ordinary light clothing during the flight without any special suits. Containers with supplies of water and food are located aboard the capsule.

The capsule resembles an automobile headlight in external shape. This shape, with a certain position for the center of gravity, provides the apparatus with aerodynamic lift of the necessary magnitude during flight in the atmosphere. By changing it, it is possible to vary direction of travel in the atmosphere. Landing the capsule by using its aerodynamic characteristics makes it possible to reduce the overloads affecting the crew by a factor of 2-2.5 in comparison to the overloads in a ballistic landing.

The change in the magnitude and direction of the lift is accomplished /95
with the aid of jet engines which allow the capsule to be rotated about its axis. This makes it possible to maneuver in the atmosphere and to change both the altitude and the direction of flight. This significantly increases the accuracy of the landing of the device. When necessary, the capsule can return to Earth on a ballistic trajectory.

In the upper part of the capsule is a hatch to accommodate the cosmonauts on launching and crossing into the orbital section of the craft.

The orbital section of the craft is essentially a laboratory in which the cosmonauts carry out their scientific studies and observations, perform physical exercises, eat their meals and rest. For this purpose, this section is equipped with places for work, rest and sleep. The apparatus for control and communication, the television camera, movie cameras and scientific instruments are located in the work areas and around the windows, in convenient locations for operation. The composition of the scientific equipment changes in accordance with the program of a specific flight. The orbital section has four windows through which the members of the crew can make scientific observations and take photographs.

During their rest period, the cosmonauts can listen to radio programs from Earth using an all-wave receiver. This section also contains a "servant" in which the food products, life support systems, scientific apparatus and also objects for personal hygiene are located. By using the portable television camera, the cosmonauts can conduct "television interviews", during which they demonstrate the internal devices of the living quarters of the craft, show views of the Earth and space as seen through the windows, etc.

The orbiting section may be used as an air lock to allow the cosmonauts /96
to go out into open space. The air lock system aboard the "Soyuz" craft is better than the one aboard the "Voskhod". The entire orbital section acts as an air lock. The cosmonauts go out into space and return through the outer hatch, which may be opened either automatically or manually. As soon as the lock has been hermetically sealed, the orbital section is again filled with the gas mixture used for breathing and normal terrestrial conditions are established in it once again. The total volume of the living quarters of the capsule and the orbiting section amounts to about nine cubic meters.

The instrument assembly section is intended for the location of the principal onboard apparatus which operates in orbital flight as well as the motor sections of the craft. A portion of this section is hermetically sealed, and conditions are maintained within it which are necessary for normal functioning of the apparatus. In particular, this is where the assemblies for the systems for the temperature regulation, electrical power supply, radio communications and telemetry, orientation systems and control using computers are located.

In the nonpressurized section of the craft, there is a liquid fueled jet engine which is used during maneuvers in orbit and also for landing the craft on Earth. It consists of two engines with a thrust of 400 kg each. Depending on the flight program and the corresponding fuel supplies, the motor section of the "Soyuz" craft can perform maneuvers at altitudes up to 1,300 km. To achieve orientation and movement of the craft during maneuvering, a special system of low-thrust motors is provided.

In space, the "Soyuz" craft flies with the panels for the solar batteries /97
unfolded, and their useful area is about 14 square meters. These panels are the principal receiving elements of the "power station" of the craft.

Manned flights are very important at the current stage of development of cosmonautics. They are opening up new and increasingly wide possibilities for practical use of space.

The excitement and wonder which formerly greeted space achievements have now been replaced by serious scientific analysis. Space has become the arena

for intensive scientific studies. This is precisely why manned spacecraft and their human crews are not only blazing new pathways into the unknown today, but are working on problems of practical use of space.

Space studies that are being performed in our country with the aid of the manned "Soyuz" craft, are intended for the further exploration of space near the Earth, the performance of a wide program of scientific studies for the needs of the popular economy, solution of the complicated technical problems, necessary for the construction of inhabited orbital stations near the Earth.

Now there is a new Soviet manned spacecraft in space -- the Soyuz-9. The program of its flight is no repetition of a former flight but a new stage in the development of complex rocket-space technology. The flight of the "Soyus-9" is bringing us closer to the construction of long-lived orbital stations in space near the Earth and laboratories in space which can become a critical means of practical conquest of space by man. The names of the people are mentioned here: V. Denisov, former scientific associate, V. Alimov, Scientific Associate.

MAN AND ROBOTS IN SPACE

/98

A. Yeliseyev, Pilot-Cosmonaut of the USSR,
Candidate of Technical Sciences, Twice
Hero of the Soviet Union

As has been reported, A. G. Nikolayev began to perform experiments aboard the Soyus-9 spacecraft which involved the study of the characteristics of man as an element in a control system in various dynamic operations. These experiments are of great importance for further improvement of spacecraft systems and the study of the conditions of interaction of the cosmonaut with diverse technical devices. This article tells about the cooperation between man and robots in space.

It is already two decades that man and robot have been successfully working on space studies "shoulder to shoulder". Automatic satellites were the first to be sent out to explore space. Now, of course, satellites, automatic interplanetary stations and "probes" are providing science with a much greater volume of information than manned flights. However, this is a simple consequence of the fact that there have been 16 manned space flights in the Soviet Union and a number of satellites in only one series, "Cosmos", is already approaching 400. A similar ratio between types of flights also exists in the USA.

The operation of all automatic craft is rigidly programmed. They can carry out studies only according to those methods which have been recorded in the "memories" of their control systems, and they can only carry out those commands which were provided for in their design on Earth. But suppose a method must be modified slightly? Suppose it has to be changed during the experiment? What if instruments have to be modified, instantly selecting the most interesting object for investigation, choosing the moment when it is necessary to use the entire arsenal of investigative devices, and when only a certain part must be used? Here, the participation of a human being is much more valuable than an automatic program. A human being frequently observes /99
phenomena whose study was not provided for in the design of the craft.

Imagine that you are tuning a radio manually and suddenly pick up a number of interesting stations at some wavelengths. You would like to expand

this frequency, but alas... the designers of the receiver may not have anticipated that you would be interested in precisely this range. The study of space, on the other hand, is really a trip into the unknown.

Not one of the devices installed aboard the satellites was able to notice the swarms of bright particles formed as the spacecraft moves through space near the Earth. It was only after the flight of G. S. Titov that they began to be studied carefully, so that it became clear that these particles were capable of "imitating" stars and "deceiving" the orientation system. During the last flight of the "Soyuz-6", "Soyuz-7" and "Soyuz-8" we noticed unusual glowing of the atmosphere. In the glowing zone, the atmosphere turned out to be three or four times higher than in the rest of the "unexcited" area. No devices had been designed for studying such luminescence and would not have picked it up. But the luminescence is interesting to study since it can tell us much that is new regarding the atmosphere and possibly it may be necessary to take it into account in designing some new control systems. It is no accident that new aircraft are always tested by highly qualified pilots and not by robots. The test pilot is able to understand what causes various phenomena that have developed during the flight, and is able to check out his guess and find the answer to the problem independently and be of considerable help to the scientists and designers. It is true that man must be equipped with instruments and not depend only on his sense organs. For example, the radiation bands would not be perceptible by human sense organs.

As a rule, any craft that flies into space serves as its own "test area". Cosmonauts in flight, under actual working conditions, test various systems which will be installed on subsequent craft. Here again the role of the human /100
investigator is difficult to overestimate. The "Soyuz-9" craft is no exception in this regard; the cosmonauts are testing the operation of a number of systems and devices, which in subsequent flights will be basic and not experimental.

The flight of any device in space consists of three separate components -- scientific studies, control of the apparatus and maintenance of conditions necessary for normal work of man and machine. The principal goal of the flight is the investigations; all of the rest play a second and auxiliary role.

It would be desireable to free the human beings to the maximum extent possible for their principal task, to reduce to a minimum the auxiliary work, handing this field of activity over to the machines, which have the valuable qualification in this regard that they never become tired, forget nothing, and make no mistakes. The rational distribution of human energies must always be determined by the level of development of technology. Now, unfortunately, technology is not in a position to completely free the cosmonauts from auxiliary work, and this situation will exist for a long time to come.

The cosmonauts must spend a part of their time in controlling the craft, and one of the most important problems in training of cosmonauts is learning artificial piloting. In many cases, it turns out that the technique can be handled by automatic devices which are capable of replacing man to a certain extent, but weight limitations prevent them from being installed aboard the craft.

We can say right off that the existing manual control, as a rule, is not used aboard spacecraft. Man must perform only a portion of the control functions. He is plugged into the circuit with the semi-automatic systems. Usually the cosmonaut must give a signal to turn on certain devices or determine visually how much the position of the craft in space differs from the required one and must give commands which are necessary for correcting the error which exists. At this time, the cosmonaut uses manual control. But the /101
knob is only a command device. Behind it stands a robot which, depending on the operating mode, magnitude of direction of the movement of this knob, formulates certain commands to the jet engine for control in the movement of the craft. There are quite a few semi-automatic systems for the spacecraft.

Aboard "Soyuz" type craft, there are many manual control systems. Here there is a system for manual orientation with respect to the Earth, the Sun, a system of manual orientation for direction of flight, a system for manual rendezvous with other craft, a system for manual stabilization of the craft during operation of the main engine, and many others. Some of them are included because they are simply much simpler and more reliable than automatic ones.

Yes, as strange as it may seem at first glance, plugging man into the control circuit increases the reliability of the system. One reason is that it cuts down the number of elements in which failure may possibly occur. In addition, man can find a way out in situations where the robot is powerless to do anything.

With the development of technology, the number of systems of manual control will decrease. The designers of spacecraft will do more to free the crew from unproductive expenditure of time and energy. Cosmonauts will be able to maneuver automatically and to carry out necessary adjustments.

The crew, of course, retains the responsibility of ensuring the necessary orientation of the ship in space, determining the flight trajectory, calculating trajectory corrections, carrying out a landing in the selected area, etc. But the crew will solve these problems with maximum use of automatic devices and computer technology.

All those control systems which operate continuously during the flight or during a large portion of the flight have already been completely automated. Without human participation, the required gas composition of the atmosphere is maintained in the living quarters of the craft, and the temperature and air pressure are kept within set levels. Without human participation, telemetric information, etc. is transmitted to Earth. In reality, the cosmonaut, besides carrying out his studies, is occupied only with control in the movement of the craft. Later this too will be essentially automatic. /102

Thus, future pilots of spacecraft will essentially become automatic stations with laboratories equipped for the conduct of scientific research and experimental studies. The crews of future craft must be acquainted in detail with the equipment of each automatic system onboard, know how to use it, how to correct defects, how to perform repairs. To do this, cosmonauts will be required to have still greater knowledge in the field of automatic control, and in the field of flight mechanics. They will need experience in performing tests on onboard systems and in working with computers.

Of course, in the future there will be further specialization among the members of the crew and a division of responsibilities which will take on a

more extensive nature and will become more profound; on the whole, the presence of "robots" aboard spacecraft will not simplify the task of the cosmonaut. On the contrary: the requirements on his qualifications will become still higher and he will require extensive knowledge in the most advanced fields of science and technology. To put it simply, the profession of the cosmonaut is no exception. New technology always calls for new knowledge.

The Ocean is Listening to the Cosmonauts /103

M. Leont'yev and A. Prokof'yev

During the flight of the "Soyuz-9" spacecraft, the cosmonauts were under the constant observation of the vessels of the expeditionary fleet of the Academy of Sciences of the USSR, currently located in various portions of the world's oceans. The engineers who are the authors of this article tell about one of them.

On a calm April day, the scientific research vessel "Cosmonaut Vladimir Komarov", the flag ship of the expeditionary fleet of the Academy of Sciences of the USSR, pulled away from the piers of the port of Odessa; the enormous domes aboard the ship sparkled whitely.

The "Cosmonaut Vladimir Komarov" is a floating scientific measurement point capable of carrying out under conditions of independent mobility practically all problems involving the monitoring of both artificial satellites and interplanetary stations.

Together with the squadron commander of the "space fleet", as these ships are called by their director, Ivan Dmitriyevich Papanin, its younger brothers are standing watch in the waters of the Atlantic and Indian Oceans -- "Nebel'", "Kegostrov", "Morzhovets", "Dolinsk", "Ristna", "Bezhitsa" and "Borovichi".

After many years of work at sea, these vessels have covered many hundreds of thousands of miles from the distant island of Kergelen to Karachi in the Indian Ocean and from Tierra Del Fuego to the island of Newfoundland in the Atlantic Ocean. What made it necessary to send these vessels into "the roaring forties", to the tropical climate of the Gulf of Guinea and the Red Sea,

and into the Azure waters of the Mediterranean Sea. Every year the Soviet program of space exploration is expanding. Many space objects require constant observation from various points on the Earth's surface. Therefore, the expedi- /104
tionary fleet of the Academy of Sciences of the USSR was entrusted with the task of ensuring reception of information and monitoring of space objects and artificial Earth satellites from regions which are beyond the limits of radio visibility from ground stations on the territory of the Soviet Union.

In 1967, the Baltic Shipbuilding plant was commissioned by the Academy of Sciences of the USSR to build an unusual vessel -- the "Cosmonaut Vladimir Komarov". Imagine the construction of a building more than 150 meters long and more than 30 meters high, in which more than 1,000 apartments, a power station capable of illuminating a city with a population of several thousand people, an engine room boasting a power of 9,600 hp, an air conditioning system capable of providing an artificial climate in all locations.

It is not the dimensions of the craft that are most surprising but the scientific apparatus which is used in these laboratories. Here there are laboratories for measuring the trajectories of movement of artificial satellites and space objects, laboratories for remote control of these devices, reception and analysis of telemetric information, laboratories with very complex navigation equipment and with the most diverse means of communication.

The "Cosmonaut Vladimir Komarov" is a universal vessel. To ensure long range space communication, it has aboard it highly directional parabolic antennas with a large reflector diameter. Every ship is in constant movement pitching and rolling, vibrating. In addition, the winds at sea are much stronger than on land. Hence, it was necessary to solve many problems so that the antenna would be constantly aimed at the object in space under these conditions and could maintain communication with it. One of the solutions is the transparent coverings for the radio antennas -- domes or, as they are more often called aboard the ship, "balls". Now the antennas are not afraid of any wind. Clever stabilizing devices and specialized computers maintain the bases /105
of the antennas in a horizontal position relative to the level of the quiet sea as if there were no waves. The antennas can follow objects in space

either automatically or according to a program calculated on a universal computer which is located aboard ship. The "Cosmonaut Vladimir Komarov" can provide communication simultaneously with several space objects. Thus, for example, in one of the modes one antenna can be used to pick up information from aboard a space object and use another antenna to transmit it to the artificial Earth satellite "Molniya-1" and then to a ground control center. This is what was done during the flight of the "Soyuz-6", "Soyuz-7" and "Soyuz-8" craft.

At the same time that the spacecraft is concluding its last daily communications session with the easternmost point of the ground control-measurement complex on the territory of the Soviet Union, the final testing of the apparatus is taking place in the laboratories of our ship. A few dozen minutes later, the command sounds through the laboratories: "Start searching for the signal!" Outside everything remains unchanged. Slowly the ship's screw turns, propelling it along a strictly defined course. However, the antennas hidden by the "balls" have begun to move smoothly seeking the spacecraft. "There's the signal!" sounds the command in the laboratory where the measuring devices of the ship are located.

"Got it!" and so it goes every 90 minutes until the spacecraft enters the zone of visibility of the ground measuring station.

The flag ship of the scientific fleet, "Cosmonaut Vladimir Komarov" serves the purposes of Soviet cosmonautics, ensuring reliable communications between the daring investigators of space and their native Earth.

Safety Techniques in Space /106

I. Konev, Engr. and Physicist

Only the thin shell of the craft separates the cosmonaut from open space with its deep vacuum and cold, ionizing radiation and current of meteor particles.

Soviet cosmonautics is characterized by strict attention to ensuring a high level of reliability of the rocket and space systems and flight safety. A threat of danger to the cosmonauts can arise in the event of failure of some technical system aboard the carrier rocket or the spacecraft. The

"Soyuz" spacecraft have a special safety system which can operate during the active phase of the flight of the carrier rocket, in the event of danger, separating the cosmonauts' cabin from the defective rocket. The cabin then descends to Earth on parachutes, making a soft landing.

When the cosmonauts are in orbit, they may be threatened by an increase in cosmic radiation caused by flares on the Sun. Long before the flight and all during it, astronomers watch the behavior of the Sun and make predictions regarding its activity. In the event of an unfavorable radiation situation, a decision is taken to descend immediately from orbit. Doses of radiation received by cosmonauts who have flown in the orbits of Earth satellites were far less than the admissible levels on all flights.

The "Soyuz" spacecraft have been designed so that the functions that are important for life are divided between different systems that operate independently of one another. For example, control of the orientation of the craft may be achieved either automatically without participation of the cosmonauts or with the use of a manual control system. Many of the most important elements and devices in the onboard systems of the craft are duplicate. Various systems and their elements are mounted inside the craft so that they /107 are spatially separate, isolated from one another and not causing interference with one another during operation. If some element in one of the systems breaks down, it will have no effect on the operation of other systems.

Special attention had to be devoted to the appropriate selection of materials from which to make the ship. Substances that are resistant to the unfavorable influences of the medium, strong and light construction materials ensure protection against radiation, meteor particles, cold and vacuum of cosmic space. Thermal protection of the housing of the cabin for the cosmonauts protects them against extra high temperatures and the considerable heat fluxes which develop during landing in the dense layers of the atmosphere.

The construction and apparatus aboard the "Soyuz" craft has undergone testing under very strict conditions, providing for testing and checking of individual systems and the complex as a whole under conditions that are as similar to real ones as possible.

The cosmonaut-flight engineer may detect some faults, evaluate the degree of its seriousness and, depending on the situation, take the necessary action. As a rule, an individual failure does not constitute great danger; it is important that it is not followed by a chain of other failures. Interrupting such a chain in many cases calles for the intervention of a qualified specialist, who is extremely familiar with the material part of the craft and all of its systems.

The construction of orbital stations designed to last for long periods of time poses science and technology many complex problems. It takes more than one space flight to test them. Failure of the pressurization of the inhabited sections of the station, disruption of the thermal regime within it (especially a fire), breakdown of their life support system (for example, a dangerous increase in the concentration of carbon dioxide) may make it necessary for the cosmonauts to evacuate the craft at once. For this purpose, it would be a good idea to send a second ferry vehicle into the plane of the orbit of the stricken craft, which would rendezvous with it and carry out rescue work. A damaged spacecraft may lose control. It is therefore necessary to devise ways of rendezvousing and docking the ferry spacecraft with the space station without using its responding signals.

The literature contains considerable discussion of plans for automatic rescue methods. The simplest of them may take the form of a protective housing equipped with a system for life support. Going out into such a "space raft", the cosmonauts, dressed in their suits, could stay in orbit until a rescue craft came. The design of the "space raft" would best be one in which it was inflatable so that it could be stored aboard the station in a deflated form.

The most complete methods of rescue must make it possible for immediate descent from orbit and return of the cosmonauts to Earth in the case of trauma, sickness, etc. Such a space "lifeboat" would have to be equipped with a heat-proof shield, engine braking system, orientation and stabilization system, parachute system, beacon and emergency supplies. This would essentially be a miniature spacecraft which would perform the basic functions necessary for life -- giving a braking impulse in the required direction for descending from

orbit and safe landing in the dense layers of the atmosphere with a soft landing on Earth or in the water.

The hunting and rescue of cosmonauts in the case of an emergency landing will require a terrestrial complex of facilities including ships, barges, aircraft, helicopters. Guided by light and radio signals from a beacon, they must be able to find the cosmonauts who have returned to Earth and render them the necessary aid.

An extensive program of orbital scientific research studies and experiments is being carried out aboard the "Soyuz-9" spacecraft by cosmonauts A. G. Nikolayev and V. I. Sevast'yanov. In particular, they are testing the operation of independent navigation systems. Orbital parameters of the ship, which are given in the TASS reports, are obtained as a result of measurements of the trajectory carried out by the terrestrial complex. /109

Automatic methods of navigation make it possible for the cosmonauts, as they make their observation from aboard the spacecraft, to calculate the orbital parameters for themselves and to obtain all the required data for correction. This increases flight safety, since it reduces dependence of the craft on the operation of the ground measurement complex and the state of communication with the Earth.

Under Control From Earth /110

A. Yegorov, A. Zerenin, Candidates of Medical Sciences,
and I. Shadrintsev, Candidate in Technical Sciences

Manned space flights have become an ordinary affair. However, every flight marks a new step into the unknown, requiring the cosmonauts to make truly heroic efforts and undergo considerable self denial.

Working conditions in spacecraft are far from easy. The comparative limitation of movement, the altered living environment, increased emotional stress and weightlessness are all factors which in some cases could lead to changes in the organism, a decrease in working ability and a deterioration of the cosmonauts' health. Thus, every new flight and the complications of its program continually pose the problem of survival of expected physical and

psychic stresses by man. Therefore, objective medical control of the state of the cosmonauts during flight is absolutely necessary.

Modern technology makes it possible not only to determine the state of the members of the crew during flight but also to predict possible functional changes in the organism at later stages in the flight. This makes it possible to prevent changes that are harmful to health and thereby ensure safety for the men in space.

Regular transmission to Earth of medical information from spacecraft is accomplished, as we know, with the aid of radio telemetric communication. Thus, for example, during the flights of the "Soyuz" spacecraft, including the "Soyuz-9", the electrocardiograms of the cosmonauts are recorded several times every day, as are the seismocardiograms (recording of mechanical vibrations of the chest cavity caused by heart contractions) and the pneumogram, the recording of the respiratory process on the basis of changes in the perimeter of the chest cavity. All of this information is transmitted over radio telemetric communication channels when the spacecraft passes over the territory of the Soviet Union.

The electrocardiogram makes it possible to measure the frequency of heart /111
contractions, data on which may be transmitted over a shortwave communication channel. This makes it possible to obtain information practically from any point on the flight trajectory. In addition, data on the pulse frequency are stored in an onboard memory device and when the "Soyuz-9" enters the area of radio visibility, the information is transmitted to Earth on ultrashort waves in a short space of time. Hence, information on the frequency of heart contractions is received quite regularly and ensures a check on the entire flight path of the craft.

Periodically (once a day) the cosmonauts perform a special physiological test -- physical stress which is carefully set in terms of magnitude and duration, after which they must hold their breath for short periods of time. The reaction of the organism to these very insignificant influences makes it possible to draw very important conclusions as to how the organism has adapted to changed conditions and tells about the working ability of the cosmonauts.

The cosmonauts measure one another's arterial pressure every day and report the results to Earth. Information is also received on Earth about the atmosphere in the spacecraft cabin -- its composition, pressure, temperature, humidity.

In addition, an idea of the health and working ability of the cosmonaut may be obtained by seeing how they carry out the operations involved in piloting the craft. Unconscious changes in movement, attitude, intonation, rate of speech, transmitted to Earth by means of radio and television, allow the doctors watching them to get important information about the physiological and psychological condition of the men.

True, the volume of information received from the craft is by no means sufficient for medical diagnosis of all ailments in the ordinary sense of the word. However, for the diagnosis of the general condition of the organism and a diagnosis of the working ability of the cosmonauts, this information is perfectly adequate, especially since the doctors who are carrying out the medical monitoring during the flight are very familiar with the individual peculiarities of each cosmonaut.

Changes in the monitored parameters of the organism during flight usually occur during their process of accommodation. They constitute the physiological norm for given concrete conditions. The system of medical monitoring ensures diagnosis of these admissible changes within the limits of the norm.

During the flight of the "Soyuz-9" spacecraft, cosmonauts A. Nikolayev and V. Sevast'yanov showed no important changes in the state of their health or working ability. Physiological parameters lay within the normal limits established for this flight.

The accumulation of experience from space flights will make it possible in all probability to gradually reduce the volume of medical characteristics that are regularly monitored. Numerous space flights by Soviet cosmonauts and their American colleagues provide a basis for hoping that rapid changes in the state of health which are dangerous for the life of a space man are not very probable. However, the long term exposure to a complex of factors typical of

space flight on the human organism has not yet been studied and it is possible that there may be some consequences which are far from harmless for the organism.

The possibility has not been excluded that at a certain stage of development of cosmonautics it will be necessary to improve the system of medical monitoring of the state of health and the working ability of the cosmonauts.

Life in Orbit

/113

B. Koltovoy, Correspondent for *Izvestiya*

The history of cosmonautics, already rich in achievements, has never yet seen such a long flight. It is already 17 days that the cosmonauts A. Nikolayev and V. Sevast'yanov have been in orbit around the Earth, carrying out an extensive program of experiments and observations. The author approached O. Gazenko, corresponding member of the Academy of Sciences of the USSR, with a request to answer several questions regarding the significance of the studies being performed aboard the "Soyuz-9".

Reporter: Why is it necessary to increase the length of space flights?

Doctor: As soon as the logic of development of cosmonautics was faced with the problem of the specific conquest of space near the Earth, only a few brief visits in orbit were insufficient. It was necessary to have systematic, long term scientific crews in space to carry out increasingly more detailed and diverse studies and observations. However, in order for the investigators to be able to live and work peacefully aboard the orbiting laboratory, it was necessary to know precisely how long man can stay in space without damaging his health.

Experiments on Earth unfortunately cannot answer this question, since they cannot duplicate some of the factors of space flight, especially prolonged state of weightlessness. Therefore, the answer must be found in the course of actual flight. And this is where care is necessary. We are gradually increasing the length of the flights, checking all aspects of the state of health of the cosmonauts in orbit and after they have returned.

Previously, the longest flight was that of the American astronauts /114
Borman and Lovell aboard the "Gemini-7". They were in orbit for two weeks. The current flight of the "Soyuz-9" is a new step along the path of increasing the duration of the stay of cosmonauts in orbit. Our doctors prepared a long time ago for increasing the duration of trips into space. In particular, one of the preliminary experiments was the launching of the "Cosmos-110" satellite. As we know, it carried the dogs "Veterok" and "Ugolek". They lived 22 days in orbit. Examination after the flight showed that the dogs had completely satisfactorily withstood such a long separation from the planet. This reinforced the conviction of the experimentors that it was possible to increase the length of manned space flights.

The daily reports of A. Nikolayev and V. Sevast'yanov regarding their sensations and the biotelemetric information transmitted from orbit confirmed the correctness of this prediction. As you know, both cosmonauts feel well and are retaining a high level of work ability.

When the "Soyuz-9" flight is over, doctors will carefully examine the cosmonauts, analyzing all of the materials that have been accumulated during the flight. We must hope that the results of this analysis will be used by the doctors to solve the problem of the possibility of increasing the length of orbital flights.

Reporter: Mention was made in the TASS Reports of the fact that the cosmonauts are studying the muscle-joint sensitivity, performing experiments and determining the tone of the skeletal musculature. What necessitated such experiments?

Doctor: One of the most important aspects of space flight from the standpoint of physiologists is the prolonged state of weightlessness. It leads to a significant change in the activity of the nerve receptors which are located in the skin, muscles and joints of man. Under ordinary terrestrial /115
conditions, these receptors make it possible for us to know precisely the position of our body in space at any time. Thus, for example, signals coming from receptors located in the soles and joints of the feet tell the brain that we are (for example) in a vertical position, or in other words, are standing.

When the body is weightless, it does not interact with any support. Therefore the position of the body in space can only be determined by using the eyes. Receptors about which we spoke earlier do not participate in orientation.

Hence, the special conditions that pertain during a stay in weightlessness force the central nervous system of the cosmonaut to develop new coordination pathways so as to ensure a precise performance of specific movement.

The receptors of which I spoke have other tasks as well. They signal the central nervous system regarding the state of muscle tone, the movements which are performed, and participate in the organization of metabolism in the muscles. Under conditions of space flight, however, certain changes in muscle tone, changes in metabolism and several other variations are possible, which doctors often call the phenomenon of detraining of the muscle system.

As you see, the disappearance of the force of gravity to which we are accustomed causes a certain change in the activity of the entire nervous and muscle system of the cosmonauts. All of these things must be studied in detail. Studies of this kind are also included in the program for the work of the crew of the "Soyuz-9".

The most natural way of maintaining muscle and cardiovascular systems in good shape is the system of physical exercise. This method, as we know, is being used by the cosmonauts. As you remember, during the first days of the flight the doctors constantly told the cosmonauts to do the entire complex of physical culture exercises in space. This insistance was motivated by /116
concern for the health of the cosmonauts, who were subjected to a long period of time in a state of weightlessness.

When the flight is over, the doctors will be interested to see how the complex of physical exercises developed for the "Soyuz-9" crew was able to counteract the effects of such unfavorable factors as weightlessness and limitation of mobility in the spacecraft.

Reporter: Several times, the cosmonauts performed experiments involving testing of changes in the contrast sensitivity of the visual apparatus. What purpose did these tests serve?

Doctor: As you very well know, vision is one of the principal pathways through which information about the world around us reaches the brain. They are right when they say that it is better to see something once than to hear about it a hundred times. Our eyes are a very precise and sensitive instrument. Naturally, the doctors want to know how the organs of vision operate under space flight conditions.

We want to find out, in particular, what the characteristics of visual acuity in space, free of atmosphere, alike. In addition, when we are talking about a long flight, it is necessary to know exactly whether the visual apparatus can retain its working ability for long periods of time under conditions of space flight, and whether it can retain accuracy in determining contrast of illumination between different surfaces. All of this must be known in order to be able to correctly interpret the results of the visual observations made by the cosmonauts during the flight.

Creation of a Planet /117

B. Konovalov, Special Correspondent for *Izvestiya*

Man must breathe, drink, eat. This is always the case, no matter where he is -- among the ice floes of Antartica, in the Sahara Desert or at the bottom of the Mariana Deep. That's how we are made. The bridle on which nature leads us is very short. A minute and a half or two without oxygen and its all over. When the ancient Romans, swollen with pride, said "I carry all of myself around with me", they forgot that "me" is the planet, the place that gave them birth. And it is only now, in the space age, that we can fully realize how much a person must carry around with him if he leaves his native planet.

The spacecraft must be a little piece of Earth -- an artificial planet, on which there must be everything necessary for human life. Man has succeeded in breaking the bonds of gravity, and manned spacecraft have made quite a few flights. However, the "biological umbilical cord" ties the cosmonauts to Earth as before. On the eve of the launching of the "Soyuz-9" spacecraft, I had a chance to see the food supplies which the cosmonauts took aboard with them. Heaps of different preserves, bread in the shape of pigeons' eggs, medical tablets carefully packed in polyethylene -- it makes them easier to eat in a

state of weightlessness. Tubes containing cabbage soup and borshch. The supply of oxygen and water also came from Earth. If these supplies were exhausted, it would be necessary to return to Earth. But you can't take too many supplies aboard. In order to lift the spacecraft of Yu. A. Gagarin into space, it took a rocket with a power of 20 million horsepower, more than 4,000 hp for every kilogram of payload.

In order for man not to be an Antaeus, in order for him to be able to live and work for a long time on orbiting space stations or spacecraft, flying for years toward planets, it is necessary to build a system for recirculating substances which will fulfill the functions of a biosphere on our planet. The founder of astronautics, K. E. Tsiolkovskiy understood this well. In his book, "Beyond the Earth", describing the colonization of space, he speaks of the "ephereal islands" with blooming gardens. All interplanetary rockets, in his opinion, must also be equipped with greenhouses. "Then it will not be necessary to carry along large supplies of oxygen and food," says one of the heroes of this book, the excess of vegetation gives us both all of our excreta and wastes will also be absorbed completely. We will take away from the plants only as much as we give them."

80% of the oxygen on our planet is formed by microscopic water plants in the seas and oceans. Therefore, it is no surprise that when the idea of a green house in space became a reality, many scientists selected chlorella as the supplier of oxygen -- a microscopic green water plant.

Two years ago, *Izvestiya* described the experiments of Siberian scientists who were working at the Krasnoyarsk Institute of Physics of the Siberian branch of the Academy of Sciences of the USSR under the direction of the late Academician L. V. Kirenskiy. They built a compact chlorella cultivator, which absorbed carbon dioxide given off by man in breathing and under the influence of light from a strong lamp converted it to oxygen. The subjects lived for many weeks in a sealed chamber which was connected to the cultivator and they breathed "chlorella" oxygen. Bottles with a total surface area of 8 square meters with a "living load" of chlorella weighing a total of one and a half kg completely satisfied the requirements of one man weighing 70 kg as far as

oxygen was concerned. With a slight degree of chemical purification, water could also make the circuit through the chlorella cultivator. These and many other experiments have shown reliably that chlorella may be the "oxygen and water" generator in space. It is completely possible from the technical /119
standpoint to build an automatic onboard chlorella factory which will be competitive in the case of a long period of operation with traditional physical and chemical oxygen and water regenerators. However, the position of chlorella is weaker on the "food front". Chlorella consists half of protein and half of fat, carbohydrate compounds and many vitamins. It contains almost all the necessary compounds required for man. However, the cells of chlorella have very hard walls which makes it difficult to process them. The most important problem is that it is very difficult to accustom people to eating chlorella.

Not long ago, however, I had a chance to attend the All-Union Congress on Controlled Biosynthesis and Biophysics of the populations, at which the problem of biological branches of life support systems (among others) were discussed. Many reports were devoted to the use of higher plants as elements in such systems. In his day, K. E. Tsiolkovskiy recommended bananas, but less exotic cultures are discussed today: potatoes, beets, wheat, cabbage, radishes, carrots.

The selection of cultures for a garden in space is far from a simple task. More than 400 types of edible plants are cultivated in our country alone, and each of them has its own advantages. The first requirement of a candidate for the title of space plant is high productivity. No less important, however, is the composition of the biomass which is obtained. The complex of plants must be selected so as to provide the people with the most valuable and nutritional "bouquet" of substances.

The daily ration for human beings must contain 80-100 grams of protein, about 400 grams of carbohydrates, 80-100 grams of fats and also a small amount of several vitamins and mineral salts.

As you can see, the "lion's share" by weight goes to the carbohydrates. /120
What kind of plants can most successfully fill the role of supplier of carbohydrates? The principal candidates mentioned thus far are potatoes, beets,

and wheat. So far, these plants have been grown only under field conditions. We do not know them with the degree of precision necessary for a space greenhouse. Experiments are still going on involving growing these plants in artificial conditions, on various nutrient soils. We must find out how these plants will behave under artificial illumination and solve other problems.

Experiments have shown that under controlled conditions the yield of potatoes can be doubled. Those plants which are prepared for space flights will be newly discovered for mankind.

In addition, those qualities which usually do not attract our attention at all are also under scrutiny. Who for example would be interested in finding out (let's say) how a particular potato will react to the effect of radiation? This is an important question in space greenhouses, however. Suppose the action of cosmic radiation changes the potatoes and their tubers become inedible after several generations?

It is even more important to understand the compatibility of the plants of the future space garden with man. There are many plants with which man gets along very well when they grow wild, but if they are placed in his bedroom at night, the story may end as a tragedy. Volatile substances emitted by plants in the course of their "respiration" may have unfavorable effects on astronauts who will get their air from the greenhouse.

Last year there was a report of a unique experiment conducted by Soviet scientists during which three subjects spent 12 months in a "terrestrial interstellar flight". In this experiment, a greenhouse with growing plants was connected to a hermetically sealed cabin where the subjects were living. In /121
containers of special resins saturated with elements necessary for normal growth of the plants, cabbage, water cress, sennel, and garden borage were grown. This was a small greenhouse, which worked in the form of a conveyor so that it was always bright green, and it supplied the participants in the experiment every day with green material rich in vitamins. It was shown experimentally that it is possible to grow higher plants in a hermetically sealed environment, using the same water many times, and that they are completely compatible with man; they are not dangerous to each other.

Recently, at the Academician L. V. Kirenskiy Institute of Physics at Krasnoyarsk a very interesting experiment was performed. The "biological branch" consisted of three parts: man, a chlorella cultivator and a special chamber with an artificial climate called the phytotron, where wheat was grown. During a long period of time, the subjects who were in the hermetically sealed chamber obtained oxygen from the water plants and wheat in exchange for the carbon dioxide they breathed out. Water was circulated in the experiment. The liquid excreta from the human beings were used to feed the chlorella. All three branches of the system turned out to be biologically compatible.

In this experiment, the subject played the role of farmer. All of the work necessary for cultivation of the wheat was performed by him. The apparatus that replaced the field was a hermetic chamber with transparent cover through which light was supplied around the clock. The "soil" was a plank with special openings in which the grains were sown. The roots and stems emerged through these holes. Periodically the roots were washed with a nutrient solution. The planks could be readily interchanged and the width between the rows could be adjusted as the wheat grew so that the illuminated area could be used most efficiently. The subject was able to taste the fruit /122
of his own labors, and not in the figurative but the literal sense of the word: the grain which he grew was used for baking bread.

In a paper by L. V. Kirenskiy, I. I. Gitel'zon, I. A. Terskov, G. M. Lisovskiy, Yu. M. Okladnikov, entitled "Theoretical and Experimental Solutions of the Problem of Constructing Artificial Exosystems to Accompany Man on Voyages Into Space," delivered recently at the 13th Congress of COSPAR at Leningrad, the results of these interesting studies were presented.

A number of experiments involving several subjects (with a total duration of 6,000 hours) showed that the contribution made by the plants to the protein ration and a considerable part of the carbohydrate as well may be satisfied by 20 square meters of conveyor culture of wheat. The continuous duration of functioning of the system reached more than a hundred days and the length of time people lived in it was three months. No biological barriers to longer functioning of the system developed in this time.

Wheat occurred to the scientists primarily because it has excellent nutrient advantages -- there is a good ratio in the grain between proteins and carbohydrates. But a large role was also played by the purely psychological approach to the choice of space cultures. In the opinion of the scientists, it would be very difficult for a Russian person on the long trip through space to get along without bread.

A Draw In Space

/123

D. Bronshteyn, International Grandmaster

So the first chess match between "Space" and "Earth" has taken place. The members of the "Soyuz-9" crew, cosmonauts A. Nikolayev and V. Sevast'yanov played for space. Colonel-General (Air Force) N. Kamanin and Pilot-Cosmonaut of the USSR V. Gorbatko represented Earth. The first move came from space. The match lasted about 6 hours in all, from the 141st to the 144th revolution. The game was interrupted twice for "domestic analysis" when the spacecraft was beyond the limits of radio visibility from the flight control center. The tense struggle ended in a draw. It is readily apparent from the moves that both sides like severe and tense situations and display no little skill and imagination in their moves. However, the fact that neither side was able to win indicates the skill of the oponents not only in the attack but in defense.

Below we have provided a record of this game. It will undoubtedly go into the annals of the thousand-year history of chess as a game which expanded the sphere of power of this clever game beyond the limits of our planet.

Start: Queen's gambit accepted.

1.	P - Q4	P - Q4			
2.	P - QB4	P X P	13.	KKtP - KKt4	B - KKt3
3.	P - K3	P - K3	14.	QR - K1	K - KR1
4.	KB X P	P X P	15.	B - KKt5	Kt - KKt1
5.	P X P	Kt - QB3	16.	Kt - KKt2	QR - K1
6.	B - K3	B - Q3	17.	B - K3	B - QKt5
7.	Kt - QB3	Kt - KB3	18.	P - QR3	B X Kt
8.	Kt - KB3	Castles KR	19.	P X B	B - K5
9.	Castles KR	Kt - KKt5	20.	Q - KKt3	P - QB3
10.	P - KR3	B - KB4	21.	P - KB3	B - Q4
11.	Kt - KR4	Q - Q2	22.	B - Q3	P - QKt4
12.	Q - KB3	Kt - K2	23.	Q - KR4	P - KKt3

24.	Kt - KB4	B - QB5	30.	B - KB4	Q - Q1
25.	B X B	P X B	31.	B - K5 ck	P - KB3
26.	B - Q2	R X R	32.	P X P	Kt X P
27.	R X R	Kt - Q4	33.	B X Kt ck	R X B
28.	P - KKt 5	Q - Q3	34.	R - K8 ck	Q X R
29.	Kt X Kt	P X Kt	35.	Q X KBP ck	K - Kt1

At this point, "Space" and "Earth" agreed to a draw.

We Get Accustomed to Space /124

Academician B. Petrov

The flight of the "Soyuz-9" spacecraft has ended successfully. Soviet scientists and engineers from a great variety of "space" specialties have obtained unique data characterizing the longest orbital flight. It is difficult to overestimate the importance of these scientific data for the further development of cosmonautics.

Space has ceased to be the scene of episodic studies. Artificial Earth satellites are carrying out systematic research work in outer space, automatic interplanetary stations are making long journeys, and meteorological satellites in the "Meteor" series as well as communication satellite "Molniya-1" are standing guard.

Manned spaceflights play an important role. The direct participation of man in space research is most effective in space near the Earth, when the Earth and its atmosphere can be observed from the craft, and observations made which are of great importance for the national economy.

The broad program of studies which was carried out by the crew of the "Soyuz-9" is a brilliant example of human capability. During this unique orbital flight, an extensive program of scientific research studies and experiments was performed.

A. G. Nikolayev and V. I. Sevast'yanov performed scientific observations and took photographs of geological and geographic objects, the surfaces of the continents and bodies of water in various parts of the globe in order to develop methods of using the data obtained for purposes of the national

economy. The study of the pictures of the Earth's surface as well as natural objects in various areas of the spectrum of electromagnetic waves, from the visible to the radio wave region -- will make it possible in the future to obtain valuable information regarding the nature of the Earth's surface, the geomorphological characteristics of the terrain, to determine the types of relief, to get information about soils, the state of crops, as well as forests.

Study of the geomorphological characteristics of the terrain and its relief will make it possible to predict the location of ore deposits and will facilitate the task of prospecting for natural resources.

Studies of the ocean made from spacecraft and orbiting stations are very promising. The information transmitted from orbit will make it possible to obtain data regarding currents, degrees of pollution of water, force of waves, accumulation of plankton, as well as to estimate the ice cover in the polar latitudes.

Another aspect of the studies conducted by the crew of the "Soyuz-9" spacecraft involves observations of atmospheric formations, the snow and ice cover of the Earth for the purpose of using these data in practical and long-range meteorological forecasting. The study of the upper atmosphere and meteorological situation by the cosmonauts in conjunction with information obtained from automatic satellites is of great importance for understanding the processes that take place in the ocean of air.

Important information is also provided by measurements made of the natural radiation of the Earth as a heated body. These measurements make it possible to obtain information not only about the temperature of the Earth's surface, but also about the state of the atmosphere.

The observations made by the astronauts in connection with the state of the cloud cover of the Earth will make it possible to detect foci of origin of cyclones, hurricanes and typhoons, and to follow their development and movement. Thus, for example, on the 5th of June V. I. Sevast'yanov saw a tropical storm on the daytime side of the planet. The waves of a coastal storm were clearly visible. On preceding days, the cosmonauts had seen a cyclone and thunderstorms. A constant orbital patrol will make it possible to provide

adequate warning of navigational hazards, will prevent or significantly reduce disasters, human losses, and will show vessels where the safest routes are.

An important task which the cosmonauts had was to carry out scientific /126
studies of the physical characteristics, phenomena and processes in space near the Earth and to observe heavenly bodies. These studies are very promising.

The crew of the "Soyuz-9" carried out a great many medical and biological studies involving the study of the influence of flight factors on human organism under conditions of a prolonged stay in orbit around the Earth. Space biology and medicine have already been enriched by many experimental data obtained during previous flights of Soviet and American cosmonauts. However, there are still many unsolved problems and it will be necessary to carry out an extensive program of studies in order to answer the problems for interested scientists.

The program of medical experiments performed by the crew of the "Soyuz-9" spacecraft included a determination of the magnitude of arterial pressure, pulse rate and respiration before and after specific amounts of physical exercise and during the performance of various working operations, tests of the vestibular apparatus, the contrast sensitivity of the eye, and processes of adaptation. The study of the results of these experiments will provide valuable material for preparations to be made for future flights.

Cosmonauts A. G. Nikolayev and V. I. Sevast'yanov performed extensive scientific and technical experiments, involving the further development of manual and automatic systems of control, stabilization and orientation of the craft and testing of automatic systems of navigation in various flight regimes. They performed experiments in astronavigation with the aid of optical systems they had onboard to observe celestial luminaries. In particular, after locking in on the star Vega, the cosmonauts used an optical sight to bring it into the field of vision of a star sensor using a system of manual orientation. They stabilized the craft with the aid of gyroscopic /127
devices as well as by turning the craft relative to a selected direction around one of its axes.

Stabilization of the craft with the aid of rotation is the most efficient way of stabilizing it. Usually the axis of stabilization is selected so that the plane of the panels for the solar batteries is perpendicular to the sun. In this position, the batteries generate the most current. When the energy demands are insignificant, for example during the time the crew is resting, and the power sources aboard the craft do not require additional charging, a certain angle is set between the plane of the solar batteries and the direction of the Sun.

Considerable interest is attached to the experiments performed by A. G. Nikolayev which were intended to study the characteristics of man as an element in a control system in various dynamic operations. The interaction of man and the systems of the craft during manual control is an important problem in cosmonautics. Its solution will make it possible to find a correct answer for designing control systems for spacecraft and orbiting stations.

The flight of the "Soyuz-9" is a routine step in the accomplishment of a broad program of studies and the conquest of space, which is being carried out in the Soviet Union. It is an important landmark on the road to new flights of manned spacecraft, an important step in the design of long-lived orbiting stations.

The general secretary of the Central Committee of the Communist Party of the Soviet Union, L. I. Brezhnev, in a speech delivered at a meeting on 22 October 1969 on the occasion of the welcome for the crews of the "Soyuz-6", "Soyuz-7" and "Soyuz-8" spacecraft emphasized: "Our science has succeeded in building long-lived orbiting stations and laboratories, critical tools for the comprehensive conquest of space.

Soviet science envisions the construction of orbiting stations with exchange of crews as a main route for man into space. They can become "cosmodromes in space", launching points for flights to other planets. There will be large scientific laboratories for studying space technology and biology, medicine and geophysics, astronomy and astrophysics."

As a matter of fact, many of the studies of space near the Earth and the atmosphere of the planet from space, many of the problems of extra-atmospheric

astronomy, long-term medical and biological experiments, etc. require the construction of orbiting stations of large size designed for long life. Expeditions to other planets also envision a launching from the orbit of an artificial Earth satellite of a heavy spacecraft weighing many tens and even hundreds of tons. Launching such space stations or very heavy spacecraft from Earth into orbit in fully assembled form would encounter enormous difficulties. It would require enormous carrier rockets with an enormous launching weight. Even putting a craft with one or two cosmonauts into orbit requires rockets with an initial weight of several hundreds of tons. Therefore, one of the principal problems of rocket and space technology will be the assembly of a station in orbit.

Each component of such a station can be brought into orbit by a separate carrier rocket. To solve this problem, we will have work out methods and systems for rendezvous of two spacecraft, injected into similar orbits, maneuvering, approach, mooring, docking, undocking, etc. We must learn to carry out these operations both with the aid of automatic devices and with the participation of the cosmonauts.

For a number of years now, the regular step-by-step development of all of /129
these devices has been going on in the Soviet Union. Let us recall the flights of the satellites in the "Cosmos" series, the "Soyuz-3" piloted by G. Beregovoy and the unmanned "Soyuz-2" spacecraft, the "Soyuz-4" and "Soyuz-5" piloted by V. Shatalov and B. Volynov, with Ye. Khrunov and A. Yeliseyev on board, the group flight of the "Soyuz-6", "Soyuz-7" and "Soyuz-8" during which seven cosmonauts simultaneously carried out scientific and technical experiments simultaneously in space, extensive maneuvers, development of manual control and interaction between spacecraft and Earth command-measuring systems.

The problem of building "human settlements in space", as K. E. Tsiolkovskiy referred to orbiting stations (he should be credited with the idea of building them) not only requires the development of processes for building stations in orbit but also systems for life support, creation of artificial gravity, maintenance systems for the station, assembly of materials and

supplies, exchange of crews, ensuring control of their flight. K. E. Tsiolkovskiy, with surprising perspicacity, pointed out the possibility of building orbiting stations and showed their considerable scientific and practical value. He formulated the idea of building stations in orbit out of ready made parts, which would have to be brought up individually into orbit by rockets; he showed ways of creating artificial gravity by means of slow rotation of the station, suggested the idea of building greenhouses aboard the station, and brought up the problem of exchange of crews.

The long flight of the "Soyuz-9" spacecraft is a new step in the solution of problems of orbital flights, a new link in the chain of preparation for the construction of "colonies in space".

They Passed the Test /130

G. Dronin, Candidate of Med. Sciences, Yu. Nefedov,
Doctor of Med. Sciences, L. Salmanov

Each space flight is preceded by a long training period on Earth. Many groups are involved in the design of carrier rockets and spacecraft, exhaustive testing of numerous systems, faultless operation of which is required to ensure safety of the flight, creation of normal conditions for life in orbit. There is no such thing as trifles in this responsible work. The lives of the cosmonauts, the success of the experiment, in which the labor of many thousands of people is invested, who have dedicated themselves to the task of conquering and studying space, depends precisely on how carefully the flight perparations are made. The following is an article which discusses the manner in which the life support systems and medical monitoring devices for the "Soyuz-9" spacecraft were developed.

The long flight of cosmonauts A. Nikolayev and V. Sevast'yanov was carefully prepared by specialists from a great many different disciplines. All manner of complicated new problems arose in connection with the technical realization of the project for the "Soyuz-9" spacecraft, and the design collective of individuals involved in their solution gradually expanded. When the system protecting the vital activity of the crew members had been basically designed and tested, a series of long complex tests began to study these

systems, as well as experiments on the ground. Complex tests were conducted in a mockup of the craft, on a real time scale with participation of specially selected and prepared volunteers. It was a sort of dress rehearsal before the flight.

The duration of the flight causes important changes not only in the scope of problems to be solved but also the very principle of dividing problems into "principal" and "secondary". Those factors which were not of great importance on short flights and were not taken into to practical consideration, acquired primary importance under these new conditions as far as the selection of the most efficient system for the onboard apparatus for the life support systems was concerned.

It was particularly important to establish the reserve capacities of the /131
regeneration and conditioning systems for the atmosphere as a function of the requirements of the crew members for oxygen and excretion of carbon dioxide. We know that these highly important indices of gas exchange depend on the nature of the professional activity, level of physical stress, composition of food, and also (to a large extent) on individual physiological characteristics of the person. On this basis, persons with various rates of consumption of oxygen and excretion of carbon dioxide were chosen for participation in the tests.

The schedule of work and rest for the cosmonauts was exactly the same as on the actual flight. Except for the time devoted to sleep and rest, the schedule called for a strict arrangement of the periodicity and duration of "space" watches, communication sessions and medical checks, performance of special measurements and tests according to the flight program, physical training, taking nourishment, etc.

It was necessary to change the sequence of sleep and wakefulness which is normal for terrestrial conditions, which is of itself not a matter of indifference for the organism. Therefore, according to the recommendations of psychophysiologists, all manner of studies of individual types of "space days" were conducted, which ensured retention of a high working ability which is required for reliable control of the spacecraft and its systems.

During the entire duration of the tests, times for work and rest were continuously measured. This method, in conjunction with the direct determination of the gas exchange factors during various forms of professional activity, made it possible to obtain a critical idea of the average daily norms for oxygen consumption and carbon dioxide excretion which were formerly used in calculations for life support systems aboard the spacecraft. It was decided to make a significant simplification of the instructions for controlling the regeneration and conditioning system for the atmosphere in flight. In the final stage of the complex tests, the optimum gas medium was maintained in the living quarters of the craft.

The gaseous mixtures that developed as the result of vital activity of man (ammonia and amines, hydrogen sulphide, methane, indole, etc.), which have a harmful effect on the organism even in small concentrations, were found during the tests to be at a much lower level than the permissible amount.

During the complex tests, means and methods of medical monitoring of the condition of the crew members were carefully tested. Thus, in particular, the tests involved a practical development of means of preventing skin irritation, which could arise during a long flight from constant wearing of systems of belts, to which sensors and electrodes are fastened for recording physiological functions. It was decided to shift the electrodes successively to adjacent portions of the skin and also to take off the belt systems during the interval between regular communication sessions.

During a long space flight, the influence of weightlessness on the organism becomes more severe. In order to keep the physical state of the organism at a required level, attained as a result of training, a special set of physical exercises was developed and tested. The system of physical training was designed to provide systematic and dynamic stresses for the main groups of muscles so as to keep the strength, endurance, speed and precision of motor reactions at a high level. It was also necessary to take into account the absence of the force of gravity in space. For this purpose, a simple and convenient training-stressing suit was designed, which increases the effectiveness of physical training. It was important that even during rather intensive /133

physical exercise during the tests, no significant changes in the gas composition in the cabin were observed.

Careful tests were also made of the food rations to be eaten in space, designed with a careful consideration of the tastes and habits of the crew members. It was important in this connection that the food ration be completely valuable both from the average daily caloric content as well as the content of protein, fats, carbohydrates, mineral salts and vitamins. In the course of long experiments on the ground, all of the food products retained their taste qualities and received a high rating by the crew members. The latter were largely able to eat the food which was packed in special tubes.

How about the personal hygiene of the cosmonauts? In making preparations for previous short flights, there had never been such severe problems as for example the daily shaving of the cosmonauts, periodic grooming of the hair and nails, collection and storage of products of vital activity. During the tests on the ground, the cosmonauts had an opportunity to take a bath and change their underwear every seven days. This showed the effectiveness of the methods of personal hygiene aboard the spacecraft.

The long flight of the crew of the "Soyuz-9" spacecraft has shown that all of its systems successfully passed the rigid test in orbit. During all of the 18 days of the flight, favorable conditions for life and work of the courageous space workers A. Nikolayev and V. Sevast'yanov was strictly maintained in the living quarters of the craft.

The Present and Future of Cosmonautics /134

S. Petrov, Former Scientific Co-Worker

The unprecedented duration of the flight of the "Soyuz-9" into the universe was not a goal in itself. This strikingly long flight has shown that man live and work for long periods of time in space, retaining a high level of working ability and a good physical condition.

Hence, an important new step has been made toward the design of long-lived orbiting stations, another problem in the Soviet space program has been

solved. We are publishing an article in which the methods of development of Soviet cosmonautics are described as well as its future plans.

Everyone has already become accustomed to space flight. It has ceased to be a sensation. As a matter of fact, following the construction of an experimental orbital station, the group flight of three "Soyuz" spacecraft simultaneously, photography of Mars, as performed by the "Mariner" automatic station, direct investigation of the atmosphere of Venus, and finally two walks on the Moon by American astronauts make it seem that there is no longer any real problem in the conquest of space which would capture the full attention of the general public. Now if the cosmonauts were to fly far, far away, to Mars let us say, the rings of Saturn or the moons of Jupiter, now that would surely excite the imagination of Earth dwellers.

Even so, have we not adopted too much of a workaday attitude in evaluating the present level of space conquests? Could people who lived 200, 100 and even 30 years ago imagine what events would excite the world in the 1960's and 1970's? We have actually achieved what our ancestors dreamed of when they made up legends and stories about flights into the sky, to the Moon and to the planets. Heroism and routine are inseparable. Nowadays, cosmonautics must be viewed through the prism of history, analyzing the sequence of achievements which led up to it, as well as through the prism of the future. Then our workaday world of today will appear before us in its true colors. /135

Space studies have laid the foundation for new achievements in highly diverse branches of human knowledge. In a very short time, cosmonautics has become one of the principal branches of scientific and technical progress.

Space has turned out to be interesting and necessary to everyone. Soviet, American, British, French, Canadian, Italian, Japanese and Chinese satellites have been launched into space around the Earth. Socialist countries are participating with the Soviet Union in studying space: Bulgaria, Hungary, the German Democratic Republic, Poland, Romania and Czechoslovakia.

In our country, numerous scientific-technical collectives have been formed which are able to solve the most important problems of cosmonautics; a powerful productive base has been built which is equipped with first class

technology. Scientists and engineers have acquired considerable experience in the study of space and in the design of effective methods of space technology.

In looking at the principal trend of the Soviet space program, we can see that the characteristic feature of it is the logical nature and the sequence of development. There are necessary steps which must be taken in order to have further forward movement. This depends on the scientific-technical and industrial-economic resources. As a rule, problems are complicated more and more as they move from one step to the next. Let us recall the most important of them: the launching of an artificial satellite (providing acceleration to the first cosmic velocity -- about 7.9 km per second) and an interplanetary apparatus (acceleration to the second cosmic velicity -- about 11.2 km per second); injection into Earth orbit, flight and landing of a manned spacecraft. Then there was the launching of an automatic device toward the Moon /136
with a landing on its surface; injection of a satellite into lunar orbit. Development of systems of ballistic and controlled launching of devices, returning at the second cosmic velocity. Emergence of man into deep space, work outside the spacecraft, flight of people to the Moon. The development of processes of rendezvous, linkup and docking of spacecraft, automatically and with human participation; group flights of several manned spacecraft forming a single system, development of an experimental orbital station.

All of these stages have been carried out successfully by people working in the field of cosmonautics around the world. Our leading position in many of them is indisputable.

It is characteristic that during the first years of man's penetration into space, the principal trends of the programs of the USSR and USA, the two leading space powers, were alike in many ways. Now, as the various problems of world cosmonautics have been solved, several differences in the trends of space investigation have become evident.

The most important page written by American investigators in the world literature of cosmonautics is the flight of the "Apollo-11" spacecraft, the first expedition to bring human beings to the Moon. This was the principal goal of the entire American space program of the last decade. In our country,

we are carrying out a planned multipurpose program of study and use of space. The leading role in the study of space, the Moon and other heavenly bodies in the solar system is currently being played by automatic devices which in the final analysis are five to ten or more times cheaper than manned ones. They allow systematic transmission of information even from those areas of space where man still cannot go, for example, Venus. Manned flights are only a part of the total program.

The principal field of activity in our program of manned space flights at /137
the present time involves space near the Earth. This is where manned spacecraft are flying to carry out systematic scientific and national-economic studies; here is where complex orbiting space stations designed for long periods of service will be built and from which expeditions to other planets may be launched.

This is where the orbit of the new "Soyuz-9" spacecraft lies, piloted by cosmonauts A. Nikolayev and V. I. Sevast'yanov. This long flight, filled with experiments, falls logically into the strict sequence of the total program. The medical and biological data obtained in the course of the experiment regarding the influence of factors of prolonged flight on the working ability of man, prolonged and diverse testing of technical system of the craft and ground-based safety systems, a broad spectrum of new scientific and national-economic studies and observations have provided valuable new practical material. It lies at the base of future manned flights, and time is coming when a constantly operating orbiting station will be built and there will be flights of cosmonauts to other planets. What will the development of cosmonautics be like in the near future, lets say in the 1970's and 1980's? How will the spacecraft and devices look which are only now being planned? First of all, one of the typical aspects of our time is the extensive "cosmization" of industry. It is a fact that scientific and technical achievements of cosmonautics are finding direct application in many purely terrestrial activities. Flight conditions in space involving high temperature drops, as well as the high requirements placed on reliability and service life mean that space technology is constantly becoming more complicated and requires continuous improvement of related products. Hence, cosmonautics is affecting the progress

of radio and electronics, machine construction, material production, computer technology and many other fields. Cosmonautics is also an independent integrator in science, combining the forces of the scientists from various disciplines for the study of processes taking place in space and on Earth.

A characteristic feature of cosmonautics during these years is the fact that man is beginning constant exploitation of space systems for national-economic purposes. In addition to the communications and meteorological satellites to which we are accustomed, new constantly operating space systems are being developed which will make it possible to check the radiation situation in space and organize a constant "solar watch"; systems will be built for monitoring forestry, the state of the waters of the Earth and many others.

Artificial satellites, as well as interplanetary stations are becoming more specialized; they are making it possible to perform extensive studies of all kinds of processes. At the same time, however, the service apparatus, systems of temperature regulation, telemetry, radio, etc. will be unified to a greater degree and designed for functioning for many years. From these automatic devices, if necessary, it could be possible to design systems for specialized purposes. The cost of automatic stations and carrier rockets will become cheaper and their launchings will make a great contribution to science and the national economy, they will be practical and will produce a striking economic effect.

Manned spacecraft and orbiting stations, on the other hand, will become more and more universal and will make it possible to carry out a broad program of scientific studies and experiments during flight. In fact, entire "institues" of scientists and engineers from different disciplines will be able to function in orbit. This will make it possible to carry out technical experiments and flight tests in orbit of increasingly more complex stations in Earth orbit as well as craft for flights to planets. /139

In many cases, heavy automatic satellites with numerous functions will be used for carrying out systematic studies in space. The apparatus aboard such satellites must be able to function perfectly for a long time.

A special role will be played by problems of international cooperation. There has already been established a system of successful cooperation between the USSR and the Socialist countries, as well as France. We must hope that international cooperation will involve many more countries. This will make it possible to expand considerably the range of the studies and to balance the money spent on cosmonautics in a more rational fashion.

We have attempted to characterize the present and future of cosmonautics. It would be useless now to go into detail and they are questionable anyway. But one thing is certain -- space is necessary for man and it will serve man. A proof of this is the successful flight the "Soyuz-9" spacecraft.

Trial by Weightlessness /140

B. Yegorov, Pilot-Cosmonaut of the USSR, Cand. in Med. Sciences

For almost 18 days, A. G. Nikolayev and V. I. Sevast'yanov worked aboard a spacecraft under conditions of weightlessness. Many specialists (biologists, doctors, designers) waited for this flight with concern. The fact is that previously it was still an open question as to whether man could live for a long period of time and work under conditions of weightlessness. Even the first short flights of Soviet and American cosmonauts showed that certain functions of the human organism undergo changes during weightlessness. It is primarily the skeleton, muscle and cardiovascular systems which are affected. It also causes development of changes in the central nervous system, hormonal system, etc. These changes are not considered to be a disease, but a so-called functional disturbance which disappear completely. However, they can reduce the resistance of the individual to overstresses which develop during landing.

And this is where preparation for a long flight began. It followed many directions. In particular, if you remember, several years ago a biological experiment was conducted aboard the "Cosmos-110" satellite, when the dogs Ugolek and Veterok were in orbit for 22 days. Then a number of experiments were conducted on the ground which made it possible to some extent to imitate the conditions which will accompany the stay of a crew in orbit. These experiments with limited weightlessness, artificially created so that the organism could be freed to some extent of the load imposed by the Earth's gravity,

and thereby approximately simulate the conditions of a stay in weightlessness. In addition, we know from American experience that the 14 day flight made by their cosmonauts was withstood with no difficulty whatever. Still, however, a flight of greater duration, regardless of the optimistic opinions, generated completely natural fears.

The entire history of mankind involves living under conditions of exposure /141
to the force of gravity. It is no accident that in the course of his evolution man has developed a rather strong skeleton and a powerful muscle system. The circulatory system which supplies nutrient substances to the tissues of the various organs is designed so that a man can lie down and stand up quite freely. Regardless of the change of direction of the action of the force of gravity, the circulatory system adjusts reliably, reacting to these changes and making corrections in its operation as needed.

And now man is to be weightless. This is a completely new state for him. During all of its evolution, mankind has never encountered it. Nevertheless, as was predicted, man evidently is able to adapt to weightlessness. This means that with each day of the flight a cosmonaut will be better and better accommodated.

It is paradoxic, however, that it is precisely this adaptation of man which disturbs the specialists and doctors. It means that the human organism begins to discard everything which is unnecessary and superfluous under conditions of weightlessness. For example, a powerful muscle system is no longer necessary. It begins to degenerate gradually. I would like to say that this process is not infinite. Naturally a man must live and he must have enough muscles to move around and to work. But the muscle system just gets weaker.

There will also be important changes in the bone apparatus of a human being. A dense bone such as that which is needed under terrestrial conditions is not necessary here. So calcium is gradually lost from the human organism -- /142
washed out, so to speak. The density of the bone tissue gradually becomes less.

The cardiovascular system also undergoes a number of changes. Excess liquid is excreted from the organism and the volume of circulating blood

decreases, so that the cardiovascular system does not have to determine (as it does on Earth) where up and down are.

When the flight is over, the cosmonaut must not only withstand the overloads but also the return to terrestrial conditions. And here the question arises: could it happen that a man, after a sufficiently long stay in weightlessness that lasts let us say several months, could become "unused" to the Earth and could not return to normal? I think that this is hardly the case. This optimism is not only based on the fact that nature is relatively flexible and that the human organism can accommodate itself to new conditions rather rapidly and well. At the present time, work is going on to build devices which will prevent the development of undesireable phenomena in the human organism. This work is proceeding quite successfully.

There are two basic groups along which mankind can travel in the further conquest of space. The first is the creation of artificial gravity aboard the spacecraft. This can be done aboard a spacecraft in only one way -- by creating some kind of rotating system in which the man would live. Centrifugal force, which develops during rotation, would imitate the constant load imposed by Earth's gravity. It is possible in general to build such a system. But it turns out that it is not very convenient. In particular, due to the combination of the rotation and the orbital movement, the station will begin to change its orbit. It will be necessary to correct it from time to time. This /143 will call for stopping rotation, starting up the correcting motors and then after correcting orbit start the rotation again. You can understand yourself that this is not economic from the energy standpoint. Besides, the whole system would weigh a great deal.

Therefore, work is now going on to build systems for physiological protection of man against weightlessness. Several routes have opened up which may have some effect on the human organism. But the principal trend, so to speak, of the idology of constructing these protective devices in our opinion appears as follows: for flights of short duration, no protection at all is necessary. For flights of medium duration (up to a month) it would obviously be a good idea to prevent adaptation of the organism to flight conditions and

to help it to resist this process. To do this, it will be necessary to affect those systems of which we spoke earlier and try to impose loads on them in some fashion. Principal efforts in this direction are directed at the development of methods of physical training. Pharmacological preparations apparently can be of some help too. Interesting studies are being performed to clarify the possibilities of the favorable effects of the gaseous medium in the spacecraft cabin. We know for example that a medium with a shortage of oxygen which is characteristic for high mountain regions will make it possible to stabilize the calcium content in the bone tissue, increase the volume of circulating blood, i.e., prevent those phenomena which accompany a stay in weightlessness.

Finally, there are the long flights. Exchanging crews in orbit is a rather complex business. And it is simply unprofitable to change them frequently: people will have to become accustomed to flight conditions. In our opinion, the crews will have to work in weightlessness. They will become adjusted and feel very well. However, a short time before the end of the /144
flight, the men must be brought out of this condition and prepared for landing by restoring their muscle mass, saturating the organism with calcium, as well as other salts and minerals which are lost from the organism during weightlessness, and "detrain" cardiovascular systems.

These of course are the principal trends of the work which will make it possible in the future for cosmonauts to make long flights. But the scientists will still have to analyze the material which is obtained and they will study the unique data which was obtained during the flight of the crew of the "Soyuz-9" spacecraft and prepare for new studies that are involved in the design of long-lived orbiting stations.

"Soyuz-9": Program Complete /145

Professor V. Pavlov

The further study of space in the interests of the development of our knowledge regarding space around the Earth and between the planets as well as the practical use of this information for purposes of the national economy involves the prolonged stay and work of man under conditions of weightlessness

and residence in limited, closed volumes. Even during the first long flights of orbital stations, the investigator will be under conditions of weightlessness for weeks and months.

Until recently, the maximum duration of human flight in space was five days ("Vostok", "Soyuz")to 14 days ("Gemini-7"). Together with the solution of individual scientific and technical problems, the vital functions of the human organism, sensations and working ability of the cosmonauts were studied. It was found that people accommodate rather rapidly (adapt) to conditions of weightlessness. The "illusion of position" which arises at the start and the unpleasant sensations when moving around soon disappear and the work of the circulatory and gas exchange organs also return to normal. However, there may be development of languid movements and a slowdown of reactions, an accumulation of stimuli to the vestibular apparatus, sometimes capable of producing symptoms of seasickness (rocking). Therefore, it is extremely necessary to carry out a careful study of the behavior of the human organism under conditions of prolonged stay in a condition of weightlessness, the influence of artificial gravity of even a very small magnitude on the condition of the organism and the sensations of the cosmonauts.

During a long flight, it is also necessary to check the working of the apparatus for control, communications and other equipment, accumulating experience and statistical data for further increasing the reliability of the design and the pressurization of the compartments of the craft as well as its accessory systems.

To solve these problems, the flight of the "Soyuz-9" spacecraft was devised. /146 Its crew, as we know, consisted of the commander of the craft, Pilot-Cosmonaut Andriyan Grigor'yevich Nikolayev and Flight Engineer, Candidate in Technical Sciences, Vitaliy Evanovich Sevast'yanov launched on the 1st of June, the spacecraft entered an orbit with a minimum altitude (perigee) of 207 km and a maximum (apogee) of 221 km. The inclination of the orbit was 51.7°. The flight which lasted 18 days ended successfully.

During the flight, the following technical problems were solved:

-- conduct of medical and biological studies of the effect of factors of prolonged space flight on the human organism;

-- complex testing and operation of onboard systems under conditions of prolonged space flight;

-- further development of systems of manual control, orientation and performance of studies with methods of automatic navigation;

-- conduct of scientific studies and experiments in the interest of further development of elements of design and systems of spacecraft.

Medical and Biological Studies

The flight of the "Soyuz-9" spacecraft is of great interest from the standpoint of space biology and medicine. Under conditions of orbital flight, weightlessness is the principal factor acting on man. From the moment when the decision was made to send man into space, this problem has always received considerable attention. Many positive results were gathered from scientific studies. But we could still not be convinced that the problem of weightlessness had been completely studied.

As the flights of Soviet and American spacecraft demonstrated, cosmonauts can live and work under conditions of weightlessness without marked disruption of their state of health or working ability for several days. However, as the duration of the flights increased, the effect of weightlessness was coupled with other factors such as prolonged isolation, limited movement, psychological stress, and finally the possibility of infection from microorganisms contained in the craft. /147

In conjunction with the goals of previous flights of Soviet and American cosmonauts, it could be said that the results of medical checks and biomedical studies demonstrated certain insignificant changes in the organism that revealed only a general trend of the disturbances which could arise under the influence of space flight factors. Their influence on the human organism turned out to be much less severe than many scientists feared at the initial stage of space investigation. At the present time, we have sufficient basis to proceed with flights of ever increasing length, having in mind the reliable and comprehensive medical-biological protection of the health of man during the conquest of space.

The experiment which has just been concluded was largely devoted to these purposes. It provided for study of symptoms of possible disturbances that would arise as a result of prolonged effects of weightlessness on man; the gathering of data on the effect on the organism of a longer stay in weightlessness than ever before and the effectiveness of protective measures, the gathering of data necessary for further improvement of life support systems.

On the basis of these goals, Soviet scientists devised various ingenious methods, devices and means of recording physiological functions of an organism in space flight. Special methods and complexes of physical exercises were employed, whose direct purpose was to retain the resistance of the organism to the influence of weightlessness and subsequent overloads on landing from orbit, to maintain muscle strength, to have a general toning effect on the nervous, cardiovascular and digestive systems.

A detailed study was devoted to the cardiovascular system by means of precise methods of electrocardiography, seismocardiography, pneumography, and pulse frequency measurement. The results were transmitted to Earth by means of radio telemetry. In addition, the cosmonauts themselves periodically measured the arterial pressure at rest and following certain amounts of physical exercise.

In close relationship to the state of the cardiovascular system, the variations of the water-salt exchange were studied; they must be used for further study of water-electrolyte balance in the organism.

Thus far, there have been no experimental data on the energy expenditure of man during space flight. Moreover, they are absolutely necessary for designing optimum systems for life support as well as for developing scientifically based food rations and water supplies.

In this connection, the cosmonauts carefully measured the functions of respiration, gas exchange and energy consumption under conditions of work and rest. They also studied the vegetative reactions, measured the muscular force of their hands, painful and other forms of sensitivity, studied the changes in the interaction of the analyzer system, and especially the function of the

vestibular apparatus. All of this is necessary for subsequent development of recommendations regarding the prevention of various disturbances which could develop under conditions of prolonged weightlessness.

Together with the reliable medical checks using methods of telemetry, /149
physiological reactions of the organism under the influence of long action of a complex of space flight factors were studied. In this plane, the psychological stability of the individual was studied, together with the dynamic characteristics of the operator included in the control system.

It must be emphasized that in the field of medical studies we used their latest methods of detection which allow a deep penetration of the physiological mechanisms which accustom the human organism to space flight factors. This is of extreme value for further improvement of methods of ensuring prolonged stay and work of man in space.

Maneuvering in Orbit

Aboard the "Soyuz-9" spacecraft, experiments in maneuvering the craft in orbit were continued (including solution by the cosmonauts of problems of autonomous navigation) and in working out the number of planned elements for orientation systems and control.

The control system made it possible to maintain any angular orientation of the craft which was required in the course of carrying out the scientific and technical experiments or maneuvers. Thus, when testing the autonomous navigation system, the cosmonauts oriented the craft toward certain stars and when they were observing and photographing the Earth they aimed it toward the Earth.

In addition, the orientation of the craft was tested with respect to the Sun, which is necessary for obtaining electrical energy for the solar batteries and carrying out a number of scientific and technical experiments. It was maintained through stabilization of the craft by rotation. Maintenance of the orbital parameters was ensured by corrections in which the correcting impulse could be given at any required direction. The correction, like many other /150
control operations, was conducted both manually and automatically without the participation of the cosmonauts. Manual control was used, cutting in one

group or another of orientation motors so that the cosmonaut guided the craft into the necessary position; using optical devices, he oriented the craft relative to the Earth with the required accuracy. Special optical devices made it possible for the cosmonaut to achieve highly accurate orientation using the stars.

A long flight calls for economic consumption of fuel in the jet engine system used for orientation. Economic consumption of fuel is ensured by employing modes of activity that serve to maintain orientation with a minimum individual pulses from groups of motors.

A special feature of the flight of the "Soyuz-9" spacecraft was the fact that a number of new orientation devices were installed aboard it. Certain characteristics of the vessel were stressed which are important for the operation of orientation systems.

In the Interest of Practice

As in the preceding flights, observations were continued of our planet from space using optical devices, photography, and motion pictures of various phenomena and processes taking place on the Earth's surface. On the basis of the photographs taken from the "Soyuz-9" spacecraft, scientists were able to correct geological charts of individual regions of the Earth and to determine the most probable regions for seeking natural resources. Similar work under terrestrial conditions involves considerable energy and resources. In addition, on the basis of photographs of individual regions of the world oceans, a study will be made with the possibility of determining ocean currents and other characteristics which will simplify the search for zooplankton and places where schools of fish can be found.

Photographs of the atmospheric formations, snow and ice covers of the /151
Earth will provide additional materials for developing methods of long-range weather forecasting and methods of recognizing the time when typhoons develop.

Studies of physical characteristics, phenomena and processes in space were performed. On this level, the influence of space conditions on the characteristics of optical systems were determined, methods of sighting landmarks on the Earth's surface were tested for purposes of navigation, and the

operation of various mechanisms under space conditions was studied. The study of the intensity of cosmic radiation, definition of the solar constant, study of the passage of radio waves of various frequencies through the atmosphere were all continued.

Design Features of the Craft

The "Soyuz-9" spacecraft, in terms of its design component characteristics, is essentially similar to the preceding craft of the "Soyuz" type. However, in accordance with the tasks associated with a long flight, provision was made for certain changes having to do with improving the working conditions and rest of the cosmonauts. The craft also consists of three basic sections: the orbital section, the capsule and the instrument assembly. Apparatus and equipment which are used for rendezvous and docking with other spacecraft were removed from it.

The orbital section of the "Soyuz-9" spacecraft serves as a laboratory for scientific experiments and studies. It is also a "residence", in which the cosmonauts rest, sleep and eat. It contains the principal scientific apparatus and equipment. This section contains the system for regeneration and thermal regulation, which provides the same atmospheric conditions on a long flight as on Earth.

To maintain a normal physical state and a high level of working ability /152
during a prolonged stay under weightlessness, the cosmonauts performed a set of exercises using a special gymnastic area with two exercising devices and a special suit. The exercising devices make it possible to develop stress on the human body. Groups of muscles and the skeleton receive stresses similar to those under conditions of terrestrial gravity. The design of the orbital section involves the introduction of additional fastenings to hold the cosmonaut in a standing, sitting or lying position. This makes it convenient when carrying out experiments as well as when resting and sleeping.

The orbital section of the "Soyus-9" spacecraft is a prototype for scientific laboratories and living quarters in orbiting stations. The work of the cosmonauts in this section will make it possible to clarify specific

aspects and to choose rational methods of performing studies under space conditions.

The capsule of the "Soyuz-9" spacecraft is made in a two-seater version. Prolonged flight and a large volume of scientific investigations required a partial change in its arrangement. Instead of the third seat, a scientific apparatus was installed, casettes with movie and still film, supply of magnetic tape for recording the results of experiments in orbit. This information as well as a number of scientific devices for biological experimentation were returned to Earth. As in the preceding craft, the capsule contains a panel with devices for indicating and signaling, pushbuttons and knobs for controlling the craft and its systems.

The landing of the apparatus from orbit is designed to produce small overloads within the limits up to three units. This is very important for a long stay of cosmonauts under conditions of weightlessness. The corresponding aerodynamic quality and characteristics ensure the possibility of stable gliding of the capsule through the dense layers of the atmosphere. In addition, the apparatus is provided with shock-cushioned chairs and braking jet engines which make it possible to reduce the overloads at the moment of landing after the parachute has been deployed.

The instrument assembly section of the craft is similar in every way to /153
the corresponding sections of preceding "Soyuz" spacecraft. It contains apparatus and equipment which are needed in the orbital flight of the craft and the descent from orbit following completion of the flight program, including a correction engine assembly, orientation motors, thermal regulation system assemblies, solar batteries, antennas for the radio systems and for telemetry.

The "Soyuz-9" spacecraft was placed in orbit by a multistage carrier rocket. After separation from the carrier, the panels of the solar batteries were deployed as well as the antennas for the radio instruments. The crew of the craft and the ground command-measurement complex use the results of telemetric measurements to perform an analysis of the condition of the craft and its systems as well as to make decisions regarding the progress of the flight.

During the flight, two-way radio communication was maintained between the crew of the spacecraft and ground stations. In the zone of visibility of ground control stations, the orbital parameters of the craft were measured, telemetric and television information were received, and radio commands were transmitted to the craft.

After the program of the flight was over, the crew of the craft prepared to land. After orienting the craft in the orbital system of coordinates, delivering a braking impulse and separating the sections, the capsule made a controlled landing through the atmosphere and touched down in the specified area.

The flight of the "Soyuz-9" spacecraft marks a new step on the road to long space flight.

CHAPTER 4. SPACE SERVES THE PEOPLE

Moscow Became Closer /157

N. Tlyzin, Deputy Minister of Communications of the USSR

What Role Did the Development of Space Technology Play in the Area of Radio Communications and Television? The author Answers This Question.

In Khabarovsk and Komsomol'sk-on-Amur, and in many other cities of the Soviet Union, you can see the silver dish of an antenna belonging to a space station in the "Orbita" system. Television transmission through space has become so common place that most television viewers no longer give any thought to how the programs reach their homes. Communications satellites serve millions of people. These days, with the aid of communications satellites like the "Molniya-1" and the network of "Orbita" stations, the people who live in cities very far away from Moscow are following the flight of the "Soyuz-9" spacecraft with admiration and pride, and groan with everybody else at the fate of our soccer team in Mexico.

Now nobody asks whether or not artificial Earth satellites can be used for such "Earthly" tasks as television transmission. The extensive program of study and conquest of space which has taken place in our country provides for the further extensive use of artificial satellites for radio communication.

I remember the basic steps of the development of space communication in our country. On 23 April 1965, the first communication satellite "Molniya-1" was launched. This formed the beginning of long range multichannel radio communication and long range television.

On the eve of the 50th anniversary of the October Revolution, a network of receiving stations for television programs via space was started -- "Orbita". The artificial Earth satellites in the "Molniya-1" series began to transmit pictures and sounds to the entire enormous territory of our country. The first program from the central television studios became nationwide.

In distant areas of Siberia, the far north, the far east and central Asia, about 30 "Orbita" stations were built in a short time. This meant that the programs of the central television studios could be seen by more than 20 million viewers. /158

The "Orbita" system is constantly being expanded, and stations are being built not only in the large cities. The numerous audience of television viewers who look at "cosmic television" was expanded only this year by the viewers of Okha on Sakhalin, Abakan and Uray. By 1971, construction of "Orbita" stations will be complete in Bilibin and Anadyr on Chukotka, in Okhotsk, Sovetskaya Gavan' and other remote points.

The "Orbita" does not serve our country alone. Recently, the Soviet television audience was joined by the inhabitants of the capitol of Mongolia, Ulan-Bator.

At the same time as the expansion of the network of "Orbita" stations, the "service obligations" were also expanded. It became possible to transmit news tapes not only over land lines but via communications satellites to the "Orbita" stations. The same channel is used for this purpose as for the television signal. This is the first of its kind in the world. The time will come when this will be an ordinary statement: "The newspaper came via space." From the printer, the signal travels over the phototelegraph line carrying the image of the newspaper tape to the space communication point, where it is transmitted via the communications satellite to receiving stations and on to the local printer. Here it is again converted into letters, words and phrases.

Those cities where the matrices of the central newspapers are received will obviously be able to make good use of the "Orbita" network.

Communications satellites of the "Molniya-1" series have now been used for five years for telephone, telegraph and phototelegraph communication between Moscow and certain other cities in the Soviet Union.

As you can see, space technology is taking an increasingly active part /159
each year in the solution of purely practical problems and we communications experts are probably the ones who feel it most.

The Earth Under the Objective

Prof. B. Rodinov

What does travel into outer space contribute to the knowledge we have of our planet? Professor Rodinov tells us about this.

First of all, it should be emphasized that the launching of automatic and manned stations into space has opened up previously undreamed of possibilities of a global survey of the Earth's surface for geologists, geographers, geodesists and other specialists engaged in the study of our planet. An extensive survey of this kind provides qualitatively new information. It makes it possible to see with one's own eyes the general outlines of the planet's appearance, which simply cannot be observed directly from Earth and even from an aircraft. Remember what the poet said:

You cannot get to know somebody by standing too close;
You learn a great deal more at a distance.

It is not only the great distance from the planet but, as strange as it sounds, the optical thickness of the atmosphere which make it possible to see from space the most significant features of the Earth's relief, the conditions of soils, and the plant cover. Astronomers invariably complain about it because it keeps them from observing the planets and stars. The /160
thickness of the air also prevents seeing fine details of the Earth's surface in observations made from spacecraft. However, it turns out that this property of the atmosphere becomes a valuable one in the case of global observations. The fact is that it obscures the secondary fine details of the picture which unfolds beneath the objective of the camera mounted aboard the satellite. As a result, the most characteristic outlines of geological structures and vegetable cover of the soil remains in the picture. Unimportant details are absorbed, so to speak, by the thickness of the air and filtered out naturally.

In my opinion, this constitutes an important advantage of photographs taken from space over the pictures obtained by means of aerial photography. Photographs taken from an aircraft contain so many of the possible details that "you cannot see the forest for the trees," and the most important details

escape notice; the latter could, for example, provide geologists with information regarding the nature of deposits of natural resources in a specific region.

Another important aspect is the fact that photographs of a given location, taken from a satellite during a short space of time, may be viewed stereoscopically, creating a three-dimensional picture of the surface relief and the cloud cover simultaneously over large territories. This is also important for cartographers, geographers and meteorologists.

I would say that satellites and orbiting stations have joined the arsenal of tools for investigation of our planet at an extremely propitious time. Each year, human activity changes the face of the Earth to an ever increasing extent. New reservoirs are built, virgin lands are cultivated, enormous open-pit mines appear at ore deposits, roads are built and settlements developed. Consequently, maps become obsolete quickly.

This is particularly true in our country, where the rate of construction /161
activity has multiplied to a tremendous extent the territory of the country. Even aerial photographs cannot reveal all the changes, let alone terrestrial methods of compiling charts. Here satellites can render invaluable assistance to cartographers. In a period literally of several days they can photograph the entire territory of the country several times. By combining the space photographs with pictures taken on the ground and from aircraft, it is possible to get a practical idea of the needs of the popular economy using new and accurate maps. In addition, photographing territories from space is cheaper in the long run than aerial photography.

It is not only the cartographers who are interested in photographing the Earth from space. It is very important for agricultural workers to know how the state of the snow cover is changing, and to be familiar with the moisture of the soil (as a rule, moist soil shows up darker in photographs than does dry soil). Photographs of the ocean's surface can tell sailors whether the waves are high in an area in which they are interested. Of course, the waves themselves cannot be seen from the altitude of the orbit. However, by studying the nature of the solar reflections on the surface of the water and the

degree of polarization of the reflected solar light, one can get a rather accurate picture of the height of the waves. Indeed, all of this kind of information can be obtained directly by using television pictures from space.

Geologists expect to get a great deal from space photography. It turns out that in order to be able to see better what is located in the bowels of the Earth, it is frequently more valuable to go higher, into orbit around the Earth. It is a fact that various forms of natural resources are associated with specific kinds of geological structures. The latter, in turn, are revealed by characteristic features of the macrorelief, and by extrusions of crustal rocks at the surface. An analysis of these features will make it /162 possible to detect regions where specific deposits should be sought, and geological expeditions can be sent there for a more detailed survey.

Is a man required aboard an orbiting station in order to make pictures of the Earth from space? Unquestionably, the participation of a qualified specialist considerably increases the range of problems which may be solved by the method of space photography, and results in a tremendous increase in the effectiveness of the use of the diverse apparatus which is used for studying the Earth's surface from space.

In order that the photographs should contain as much information as possible, pictures should be taken in various portions of the spectrum. For example, pictures taken in invisible infrared light reveal what remains hidden to the unaided eye. This means that the situation must be sized up rapidly and that apparatus switched on which is most valuable for use at a given moment. Automatic devices cannot solve problems of this type. Reloading the cameras, changing the light filters, selecting information for immediate transmission to Earth, fine adjustment and regulation of the instruments -- all of these require the presence of a specialist aboard the space laboratory.

The Soviet cosmonauts who flew in the "Vostok", "Voskhod" and "Soyuz" spacecraft performed many valuable observations of the Earth's surface, cloud cover and optical phenomena in the atmosphere. As we know, the program of work for the crew of the "Soyuz-9" spacecraft included scientific observation and photography of geological and geographic objectives, the surfaces of the

continent and bodies of water in various regions of the Earth's surface. All of these are initial (but very important) steps. We can say with certainty that the study of the planet from space will play a role of increasing importance each year in the discovery and diligent use of those natural resources which we have.

For the Arsenal of Earth Medicine /163

Academician V. Parin

What influence will the development of space medicine on the solution of problems faced by "Earth" doctors? Academician Parin tells us about this.

When the progress of space technology had prepared the soil for the establishment of a completely new profession of pilot-cosmonaut, the doctors were naturally faced with the problem of the health criteria to which its representatives must correspond. Everyone knows that the cosmonaut must be an absolutely healthy person. But what does "absolutely healthy" mean? It turned out to be not such an easy question to answer.

During the thousands of years that medicine has been in existence, doctors have accumulated a tremendous amount of experience in diagnosis and treatment of the most diverse diseases. However, as strange as it sounds, healthy persons have been studied much less than sick ones. It may be for this reason that it is so difficult to recognize the early and latent forms of a disease. In order to be able to recognize the fine boundary between health and sickness, it is necessary to be very familiar with the symptoms not only of the disease but of health as well.

The statement of the problem seems clear to us at the present time. But scientists were stimulated to work on its solution in earnest by the need to develop criteria for the selection of cosmonauts, the requirements of space medicine involving classically healthy trained people. The accumulation of detailed knowledge regarding the appearance of a healthy organism was necessary for recognizing the most insignificant deviations of the state of health from normal, in other words, for the early diagnosis and prevention of disease.

The achievements of space physiologists are beginning to find their way /164
into clinical practice as well. Soviet scientists are in the lead in this respect. For example, we could mention seismocardiography -- a method of studying cardiac activity. It was developed in the Soviet Union for checking the state of health of cosmonauts during orbital flight, and is now used successfully for studying patients. In this method, the slight vibrations of the body caused by the beating of the heart are recorded. The seismocardiogram gives the doctor a fairly complete idea of the pulse rate force and synchronization of cardiac contractions, as well as circulation parameters. This method is now used in clinics for studying patients with atherosclerosis and myocardial infarct, hypertension and heart defects. In most cases, it is highly effective in diagnosis. Hence, the achievements of space medicine have already made their way into the arsenal of practical hygiene.

I would like to give one more example of a rather unexpected application in the clinic of results obtained by space physiologists. One of the serious problems of prolonged space flight is that the crew members aboard the spacecraft are forced to adopt a static way of life -- they cannot do too much walking around the cabin. Prolonged limitation of mobility, which the doctors call hypokinesia or hypodynamia, has an unfavorable influence on the organism. Changes begin to occur in the activity of the cardiovascular system, in the nature of the metabolism, in the muscles and even in the bones. First of all, it was necessary to study all of these changes in detail and then to find ways of keeping the cosmonaut's organism in a normal condition despite the restrictions placed on his movement.

The investigation and discoveries performed by physiologists working on the problem of hypodynamia have been found to be extremely valuable for the proper organization of a regime for those patients who are confined to bed for /165
long months.

There is still another trend in space medicine which finds direct application in hygienic practice -- the development of various pharmacological preparations which protect cosmonauts against unfavorable influences of the surrounding medium. To be sure, preparations which increase the resistance of the organism to the action of cosmic radiation under conditions of orbital

or interplanetary flight are needed on Earth too, for protection against radiation disease. There is also a wide range of application for the medicines which increase the mental and physical working ability of cosmonauts under conditions of prolonged stress.

Finally, I feel that it is necessary to mention the intensive nature of the improvements that have taken place in medical technology and the precise methods of investigating the condition of the organism which are largely linked to the requirements of space medicine. Let us take for example biotelemetry -- measurement of the characteristics of the activity of various systems of the organism over a distance. This is the only way of monitoring objectively the state of health of cosmonauts in flight. It is not possible to depend on their subjective opinions alone. Moreover, no one could tell the doctor as much as the tapes with the recordings of the electrocardiograms, seismocardiograms and other objective characteristics of the activity of the systems of the organism.

Radio technicians, working together with the doctor, have contributed a great deal to the development of reliable, compact biotelemetric devices for spacecraft. Mathematicians have participated in the development of methods of rapid analysis of an enormous quantity of information which reaches ground stations over the biotelemetric communications channels. Everything which has been done for the sake of cosmonautics involving the remote monitoring of human health can be used in practice on Earth.

I will give an example which shows the value of biotelemetry for purposes /166
of diagnosis. In a certain hospital, electrocardiograms of persons suffering from atherosclerosis were recorded to monitor their activity during walks. In more than half the patients, the changes in the electrocardiogram which were indicative of the disease showed up only on the tapes that were recorded during walking. Biotelemetric methods of monitoring are necessary to study the organism of athletes during training and competition, to study the working conditions in various industries, and for monitoring the condition of seriously ill individuals under clinical conditions from a central station.

No doubt I have named far from all the applications of the results of space physiology and medicine in medical practice and the prevention of disease, as well as in the solution of practical problems of hygiene. But I think the examples I have given will suffice to show that space medicine is increasingly active in helping medicine here on Earth in its struggle for the health and life of human beings.

A Telescope in Orbit

V. Kurt, Doctor of Physical and Mathematical Sciences

What does the possibility of travel into outer space offer to astronomy? This is question is answered for *Izvestiya* by the author of this article.

All of the information regarding the planet, stars, galaxies, and interplanetary and interstellar media comes to astronomers through the medium of radiation from these objects. However, not all forms of radiation can penetrate the thickness of the Earth's atmosphere to reach the surface of the planet.

Rays of visible light, a portion consisting of heat (or, in other words, infrared rays), and a portion of radiation whose wavelength is in the radio region, are all that reach the surface of the Earth. Ultraviolet, X- and /167
gamma-radiation from space objects are completely inaccessible to investigators working at observatories on Earth. Consequently, instead of the total information conveyed by the radiation from a given star, we get only the portions which are not filtered out by the atmosphere.

There is another disappointment for astronomers, too. The air layer of the atmosphere is always in motion, so that its optical properties are continually changing slightly. This fact dulls the "sharpness" of Earth's telescopes considerably. So a star which should appear on the photograph as a point is blurred into a spot, so that a precise image of the details of the relief of the planet cannot be obtained.

After this introduction, I think it will be clear to you how excited astronomers were as they waited for the possibility of lifting their telescopes and other devices beyond the limits of the atmosphere. In fact, the

launching of instruments into space has marked the beginning of a new stage of development of the oldest of the sciences -- astronomy. Artificial Earth satellites and interplanetary automatic stations have become platforms for the rapid development of new branches of our science, dealing with the study of the information which is conveyed by ultraviolet, X- and gamma-rays, emitted by objects in space.

There are many other problems which the science of the Universe simply could not handle without space technology. For example, it is impossible to photograph the other side of the moon from Earth. For example, it is impossible to measure the magnetic field of Venus without sending instruments to the vicinity of this planet, etc. The use of powerful rockets has made it possible for astronomers to learn a great deal about the atmospheres of Venus and Mars, to obtain samples of lunar soil for investigation in terrestrial laboratories. In short, we are going beyond the limit of astronomy itself, which prefers to work with a study of radiation. If we speak of the successes /168
of astronomers in this "classical" area, we must mention above all the achievements in the field of X-ray astronomy. At the present time, scientists know about 50 sources of X-ray radiation (remember, that they could not be picked up from Earth at all). Thus far, only four of them have been identified with known objects. One of these is a pulsar located in the center of the Crab Nebula. Two others are the remains of novas. Another source of X-radiation is a galaxy which is a tremendous distance away from us. As measurements show, this "X-ray" galaxy "emits" the overwhelming part of its energy in the X-ray range. Besides these separate (or, as we say, discrete) sources, astronomers have found a type of X-radiation that comes from the entire sky. Apparently, its nature has something to do with the intergalactic medium.

Interesting results have been obtained by investigators who are working in the ultraviolet region of the spectrum, studying the Sun in particular. The ultraviolet radiation from the Sun originates in the external regions of the star -- in the chromosphere and the corona. Deciphering of the information carried by these rays will make it possible to understand the structure of the

chromosphere and the solar corona, the processes of interaction of powerful magnetic fields, and to study proton flares and other phenomena of solar activity. Apparatus for recording ultraviolet and X-radiation from the Sun was mounted, for example, on the satellite "Intercosmos-2". It is possible that the study of the X- and ultraviolet radiation from the Sun will make it possible for us to predict the occurrence of proton flares ahead of time. Forecasts of this kind are necessary to ensure the safety of flights made by cosmonauts.

How can a manned orbital station be used for astronomical purposes? In /169
particular, a telescope can be mounted there. Even a comparatively small instrument with a mirror diameter of about a meter, launched into orbit, will make it possible to see objects about 100 meters in diameter on the Moon, while on the surface of Mars it will be possible to pick up details of the relief that are 15 kilometers or more in diameter. For the sake of comparison, let us recall that the largest of Earth telescopes cannot pick up details on the Moon that measure less than a kilometer. From an orbiting station equipped with a telescope, such as the one I mentioned, it would be possible to detect planets associated with other stars, even those that are tens of light-years away from us. This is an absolutely impossible task for terrestrial observatories.

Since the telescope must be stabilized in space with high accuracy during the period of observation, the instrument will probably have to be located outside the spacecraft itself. In fact, under conditions of weightlessness even the tiniest movements of a cosmonaut can cause rolling of the spacecraft. Hence, it is extremely difficult to hold a manned spacecraft in a given position with the accuracy which is required for astronomical observations. But I certainly do not want to say that men are not needed aboard astronomical orbital stations. On the contrary. An automated telescope aboard a satellite would be a complicated and very expensive instrument. Finally, it would require qualified examinations. The presence of a cosmonaut-astronomer will make it possible to use the instruments more effectively after they have been launched into orbit around the Earth, for the welfare of science dealing with the world around us. No doubt, the development of cosmonautics will enable

astronomy to penetrate much deeper into the essence of the laws which govern the Universe. In the final analysis, this will unavoidably be reflected in the rates of development of those branches of science and technology which are directly involved in practical applications.

Ocean Patrol /170

Yu. Novikov, Candidate in Technical Sciences

How can space technology be of help to oceanologists? Yu. Novikov answers this question.

The ocean has not yet been conquered, although its resources are enormous. Suffice it to say, that at the present time the Soviet Union gathers about 6 million tons of marine products in the seas and oceans. However, 80% of this haul comes from coastal regions. In addition, the intensity of industry in these areas is very high, and we cannot count on an increase in the "contribution" here. Consequently, fishermen still have to go out to the open sea.

We know that a careful search must precede successful fishing. Industrial objects are concentrated primarily in the surface layer of the water to a depth of 50 meters. It has also been found that the migration of schools of fish and other marine organisms, the density of their numbers, distribution by types all depend to a large extent on the state of the water masses. Thus, for example, fish and squid are most frequently caught where different water masses come together. Their movement depends on horizontal current and the vertical rise of water from the depths.

To be sure, the seeking of industrial accumulations of fish or other marine animals requires practical information regarding the movement of water masses within the limits of the entire aquatorium of the world ocean. These data would be valuable to have for periods ranging from 10 days to half a month. The area of the regions in which the search takes place covers 250 to 300 million square kilometers. In order to get the necessary information from such a territory, it would be necessary to have several tens of thousands of ships. Only space apparatus can handle such a problem. It is they which

must provide the mapping of currents, and measure the temperature of ocean water with high accuracy. /17

The gathering of schools of fish primarily in the surface layer makes it possible to hope that they will be able to be detected from an orbiting station. In addition, many forms of schooling commercial fish give off specific fats as they move, which show up on the surface of the water. The spectral characteristics of such oil films differ sharply on the characteristics of the surrounding water surface.

Study of the distribution of zooplankton in the world ocean is of particular importance. These microscopic animals not only serve as food for the overwhelming majority of inhabitants of the ocean but they themselves may (and probably will) become a commercial object in themselves. "Plankton searching" can also be carried out by space devices.

Space technology is introducing important changes in methods of investigating the world ocean as well. We can assume that satellites will make it possible to improve and enlarge our ideas about the dynamics of the movement of oceanic water masses. Obviously the chart of the world ocean will be considerably defined and expanded, making it possible for us to detect seasonal and yearly changes in surface temperature, currents, water movement, etc. Global and practical study of changes in the chemical composition, salinity and density of the water are no less important for the study of the ocean. Information of this kind, of course, can be obtained to some extent directly by means of apparatus mounted on the satellite while other forms of data can come from instruments aboard automatic buoy stations anchored in various parts of the ocean, whose signals will be picked up by satellites flying over them.

The construction of a space system which will make it possible to study and use the ocean is far from an easy one. But it will unquestionably be worked out in the years to come and will not only make it possible to have a considerable increase in the amount of marine products but will also make a large contribution to the task of breeding commercial inhabitants of the seas and oceans. Several studies involving the investigation of the ocean from space are being carried out by the crew of the "Soyuz-9". /17

Orbital Weather Watch

K. Kondrat'yev, Corresponding Member of the Academy of Sciences of the USSR

What contribution does travel into outer space make to terrestrial meteorology? The author tells us about it.

The importance of weather processes in human life is generally known. The deaths caused by natural phenomena associated with weather are enormous. Let me give one example: in 1969, only one typhoon, "Vera", cost Japan 1,280 million dollars. But even if we don't speak of such catastrophic phenomena as hurricanes, floods, droughts, there are still the unexpected rains, frosts, and other "slight annoyances" which nevertheless cause considerable disturbance in the economic activity of man. In a word, the need for a reliable and sufficiently long-range weather forecasting system is felt by all of us.

To solve this enormously complex problem, we require systematic observations on the scale of the entire planet. For example, a cyclone that develops over the Atlantic requires only two days to reach our territory. Consequently, it is necessary to know what is going on over the ocean today in order to be able to tell what the weather will be like in Leningrad on the day after tomorrow. However, in order to be able to make a forecast for a week, it is necessary to know precisely the weather conditions over the entire globe. As we have said, it is necessary to have global meteorological information. The only realistic method of obtaining this is to use meteorological Earth satellites. The ground-based weather service is simply not in a position to make observations of the areas above the oceans, which cover more than two-thirds of the planet's surface, mountain regions that are difficult to reach, and deserts. However, satellites which fly around the planet will give us information about the weather over the entire territory of the Earth, whether it be ocean or Antarctic continent. /173

From the very first days that meteorological satellites were in space, they began to pick up the origin of hurricanes over the oceans. This made it possible to improve considerably the task of keeping an eye on these dangerous weather phenomena. Our "Meteor" space system carries out its work regularly,

supplying ground stations with a tremendous amount of extremely valuable information about the weather. It is a fact that all of the expenditures on space meteorology have already been made up many times by the reduction of losses due to only a few hurricanes and typhoons as a consequence of timely preparation for their arrival.

In the early stages, meteorological information transmitted from satellites took the form of television pictures of the cloud cover of the Earth. In other words, we obtained a qualitative picture of the conditions of the weather over the planet. To be sure, this was a tremendous step toward the improvement of forecasting. Now science has taken a new and no less important step. I am speaking of the shift to the obtaining of digital information from meteorological satellites. This makes it possible to use the entire capacity of computers for preparing weather forecasts.

Of what does this change consist? We are learning to measure meteorological characteristics of the atmosphere from satellites. The difficulty here is that the space apparatus flies at altitudes of several hundreds of kilometers and we are interested in atmospheric characteristics at altitudes of up to /174
30 kilometers from the surface, since this is where the "weather kitchen" is located.

Scientists have found methods of determining these characteristics by measuring the heat flux moving from the Earth into space from the satellite. A large contribution to the development of these methods was made by Soviet workers in the field of space meteorology. This was clearly evident at the International Symposium on Remote Sounding of the Atmosphere which was held on the occasion of the 13th Congress of COSPAR, which took place recently in Leningrad.

Automatic orbiting meteorological stations are now and will be of tremendous importance. But this by no means excludes the participation of man in weather forecasts from space. The presence of a qualified meteorologist aboard a long-lived orbiting station is extremely desireable. First of all, only a human being can reliably select an object for investigation which is most important at a given moment. Let us say that it is absolutely unnecessary

to photograph the entire surface of the planet in order to detect some specific phenomenon or to study its consequence. But this cannot be done, no matter how much we work with automatic devices.

A specialist who is on watch aboard an orbiting satellite, will either carry out concrete measurements for ground stations or by analyzing the situation will himself decide what objects need to be studied and which instruments are to be used for this purpose. Our cosmonauts carried out meteorological observations repeatedly. For example, V. Shatalov observed a large cloud vortex associated with a large cyclone over the Atlantic. V. Volynov observed a storm over an extensive area of South America; over the Indian Ocean, he saw a tropical cyclone born. The reports of the cosmonaut were used by our meteorologists and forecasters.

A. Nikolayev and V. Sevast'yanov, who were aboard the "Soyuz-9" spacecraft, carried out many hydrometeorological observations and experiments. Thus, for example, they photographed the glaciers and cloud cover, as well as tropical storms in the Bay of Bengal. The cosmonauts also participated in a complicated experiment during which atmospheric observations over one of the areas of the Indian Ocean were conducted simultaneously aboard the "Soyuz-9" spacecraft, aboard the meteorological satellite in the "Meteor" system, and aboard the scientific research vessel the "Akademician Shirshov". Such experiments are of great importance for improving the weather service. /175

It is possible that long-lived orbiting stations may be used to give emergency signals about dangerous weather phenomena developing in various regions of the Earth's surface. A meteorologist-cosmonaut will determine the degree of development and the direction of movement of cyclones and hurricanes, and be able to warn locations on Earth about the impending danger. Flying over the polar regions, he will be able to measure the state of the ice, and this is very important for ships traveling in the Arctic latitudes. Being limited to the scope of the problem which I have been given, I naturally will not touch on other problems of the national economy which could be solved by cosmonauts watching the surface of the planet.

In conclusion, I would like to say several words about the ways in which the effectiveness of the meteorological satellites is being improved. We are now using television pictures transmitted from orbit only for meteorological purposes. But these pictures are much richer in content. We can use them to see not only the cloud cover but the surface of the Earth with all its details. Consequently, we can use them to determine the degree of moisture of the soil, as well as the condition of forests, and the crops on farmland. Photographing /176 the surface in infrared light will make it possible to perform a detailed study of ocean currents, activity of volcanoes, as well as to detect forest fires and their limits beneath a cover of smoke.

Systematic observations made from space will enable us to considerably improve our knowledge of the planet, on which we live, and to use its natural resources more completely.

Foresters in Orbit

Academician A. Zhukov, Director of the Forest Institute of the Siberian Branch of the Academy of Sciences of the USSR

What does forestry from space offer mankind? The author tells us.

The study of forest methods from space is one of many national-economic "professions" of cosmonautics which we are now seeing under development. During the flights, cosmonauts are now observing forest fires with the unaided eye and have reported this to us on numerous occasions. The fires are especially visible at night. Later on, apparatus will be developed which will be specially designed for detecting fires and will be able to give their coordinates exactly. This apparatus may be located either on specially built automatic satellites or on long-lived orbiting stations which will be placed in orbit in space in the future.

The observation of the fires is a very important task for space forestry, but is far from being the only one. It may be of significant assistance, for example, in combatting pests. As a matter of fact, ordinary aerial photographs have alredy made it possible to detect the moment of development of a focus of pests and to take measures in time. But here there is still a large

element of chance, and satellites will make it possible to carry out this work regularly. /177

In general, it should be mentioned that improvement of the quality of space photographs taken in various regions of the electromagnetic wave spectrum will allow practically all problems that are currently solved with the aid of aerial photographs to be transferred to the "shoulders" of satellites. The satellites also have the invaluable advantage that their position in space allows us to cover millions of hectares of forests at a time.

Space patrols of the forests will not only make it possible to compile detailed charts showing types of trees, their growth, but also the direct observation of their lives, and to see how the dynamics of processes taking place there changes, and to watch the consequences of human activity. In particular, in those areas where intensive lumbering is going on, this is important. With the aid of apparatus mounted on satellites, it is possible to get a qualitative idea of the degree of snow cover before the beginning of melting of the snow, and further pictures will provide an idea of the supply of water over large territories and will make it possible to analyze the water-regulating role of forests with various types of trees in them and with different kinds of soil. Space photography will make it possible to study in greater detail the factors which cause soil errosion, and will permit a proper evaluation of the role of forest vegetation in the struggle against emergencies.

On the whole, an analysis of the data which we will be getting in the future from orbit, will make it possible to get a better idea of the factors which determine the life of forests, and will enable specific forestry measures to be taken and to make the necessary forecasts.

We are pleased to note that there is a man aboard the "Soyuz-9" who has been educated in forestry techniques; as we know, A. G. Nikolayev went to a technical school majoring in forestry. I hope that the flight of the first "Cosmic forester" will give us some interesting new information.

Colonel Andriyan Grigor'yevich Nikolayev

In 1962, pilot-cosmonaut of the USSR Andriyan Grigor'yevich Nikolayev flew aboard the "Vostok-3" spacecraft.

After the flight, hero of the Soviet Union Andriyan Grigor'yevich Nikolayev took an active part in the training of cosmonauts. In recent years, he himself prepared for flight.

Let us recall the most important chapters in the life of Andriyan Nikolayev. Andriyan Grigor'yevich was born on September 5, 1929 in the village of Shorshela in the Chuvash ASSR. After completing technical school and the Frunze Military Aviation Training School, Andriyan Nikolayev served in the Air Force. Beginning in 1957, A. G. Nikolayev has been a member of the Communist Party of the Soviet Union. In 1968, he graduated from the N. Ye. Zhukovskiy Military-Aviation Engineering Academy. Andriyan Grigor'yevich Nikolayev participated extensively in political activity, as a deputy to the Supreme Soviet of the RSFSR.

Cosmonauts Valentina Vladimirovna Nikolayeva-Tereshkova and Andriyan Grigor'yevich have a daughter, Yelena, who is six years old.

Vitaliy Ivanovich Sevast'yanov

He was born on July 8, 1935 in the city of Krasnouralsk in the Sverdlovsk oblast'. Vitaliy passed his childhood and school years in the city of Sochi.

In 1953, after finishing high school, Vitaliy Sevast'yanov attended the Moscow Aviation Institute.

In 1959, Vitaliy Ivanovich graduated from the Institute and began working at the Design Office. Soon he became a graduate student at the Moscow Aviation Institute, completing his studies successfully and preparing a dissertation to become a Candidate of Technical Sciences.

In 1963, Vitaliy Ivanovich Sevast'yanov joined the ranks of the Communist Party of the Soviet Union.

Among the cosmonauts, Engineer Sevast'yanov completed the entire program of preparation for space flight.

Vitaliy Ivanovich's wife, Alevtina Ivanovna, graduated from the Leningrad State University and works at the Scientific Research Institute.

The Sevast'yanov's daughter, Natasha is seven years old.

Hero in the Eyes of Heroes /182

If somebody suddenly told you to write an article about Andriyan Nikolayev you couldn't be blamed for clapping your hand to your head. What to write? So much has already been written about him. "Cosmonaut No. 3" from the legendary "Gagarin Guard", a man who is so well known within the limits of our solar system.

I decided that this was a situation in which one head was good, two were better and three, four, five, as many as necessary was what was needed; let his comrades and friends tell about Nikolayev, the men who lived together with him. Let this be a "mosaic" portrait. You can judge from the individual sections about the man. And so I went to Star City.

I got to know Pavel Popovich on the tennis court, where he had happened to lose a game. One doesn't usually feel calm after a tennis game, but the Sun was scorching too. Maybe this is why he recalled his trip to Brazil.

"One day we went to a large snake farm. Our polite hosts suggested that we put a boa constrictor or something like that around our necks like a collar. They said that it wasn't poisonous and wouldn't bite.

I of course stood aside. I have been unable to stand these crawling things since childhood. But Andriyan cooly put it around his neck like this and smiled.

The reporters clicked their shutters like machine guns. Next day, all of the newspapers published photographs captioned "Fearless cosmonaut, etc."

You understand, he is a nice guy. He likes to do nice things for people.

We often had to make appearances together. Andriyan noticed that I preferred to talk about weightlessness."

'Okay,' he said, 'let's divide it up. I'll talk about the launching and the landing, and you talk about weightlessness -- it's better for you that way.' /183

"A small thing, of course, but typical. He is very attentive and kindly toward everybody. You should go talk to Leshey. He tells interesting stories."

But I couldn't get any stories out of Aleksei Leonov that time. He was in a hurry. His suitcase was already packed. He had his ticket to Tokyo and back in his hand. They were waiting for him at Expo-70.

"Nikolayev?" he asked. "There's a guy who never gets upset. Absolutely imperturbable fellow. Incredibly calm," he repeated once again with some amazement. He shook hands and hurried off to talk with somebody on the telephone.

Viktor Gorbatko was not in a hurry to go anywhere. He made himself more comfortable, and began on a confidential tone:

"We were Nikolayev's neighbors. Our doors opened on the same staircase. Quiet, you say? Externally, he was phlegmatic. That's true. But you try playing chess with him. Even if he loses two games in a row, he doesn't give up. Even if he still doesn't win after that, he still doesn't give up.

"The main thing about him, of course, is his fantastic consciensousness and perseverance. I tell you the truth, I envy him sometimes. I only started studying English with him at the Zhukovskiy Academy. Its difficult, of course, at our age. Sometimes you feel like playing hookey: going skiing or taking a walk in the woods. I would take a look at Andriyan to see if he might be tempted.

'Well,' I asked him, 'done your work?'

'Its done,' he would say.

"I had to put away the skis and sit down to do my English. I didn't feel like leaving him behind.

"I would lie down to sleep and Andriyan's light would still be on. He was pouring over his books. Solving problems. He wouldn't go to bed until he

had solved them. His summaries were always most complete. According to him, many children pass the examination. He was the same way during training -- he wouldn't rest until he had 'dragged' all knowledge out of the instructor. /184

"He is a good comrade and helped out on many occasions when it was necessary. He helped me a lot when I hurt my leg. Support means a lot at such times.

"I like his relationship with his daughter. When she stays with him, she never misbehaved. If he notices something serious, he simply says to her: 'Alena, sit down and be quiet,' and it is as if she disappeared. Andriyan is a nice and omnipotent daddy for her. What a funny thing that was! We were on vacation near Sochi. Sitting on the beach, sunning ourselves. But the sea was still cold. Andriyan playfully splashed some water. She squealed and scolded him: 'Why did you do that daddy? The water is cold! Warm up the sea first!'

In the Star City Museum Tat'yana Filippovna Belyayeva showed me another Nikolayev. "Look, these are all him," she said, spurting out a pile of documents in red, blue, brown, printed and plain envelopes on the table. I opened a few at random. "Master of the Golden Hands" at the V. I. Lenin 'Arsenal' Factory. Honorary worker at the "Kievlyanka" hosiery factory, honorary citizen of the city of Leningrad, pioneer of school No. 429 in Moscow, shock worker of Communist Labor..."

In the archives of the Museum, there are files of newspapers, books, diplomas, decrees, and boxes of telegrams.

'THE COLLECTIVE OF THE MARIINSKO-POSADSKIY FOREST TECHNOLOGY TECHNICAL INSTITUTE CONGRATULATES YOU WARMLY ON YOUR BIRTHDAY STOP WE ARE VERY HAPPY AND PROUD OF OUR GRADUATE WHO HAS ACHIEVED SUCH A HEROIC EXPLOIT STOP WE WISH YOU OUTSTANDING SUCCESS GOOD HEALTH AND HAPPINESS IN YOUR PERSONAL LIFE'.

"Before taking off for Denmark, I would like to extend my most sincere congratulations to you on your birthday. Much happiness to you and many years of life. Say hello to your mother and relatives.

Yuriy Gagarin"

There are letters from friends, neighbors, fellow countrymen and relatives, as well as people he never met. He seemed close to them all. They saw themselves in him, they joined his brigade. He became the personification of the launching of our entire homeland. They were proud of him. They loved him. And there was no hiding from this love. /185

I draw from the bookcase one of the first boxes that arrived. There are some lines written by the young employees of a Cheboksarsk television studio.

Dear Andriyan Grigor'yevich!
We promised the cosmonauts
To grow very strong
The dreams of the pioneers
Are developing in a sunny tomorrow.

We'd like to go to space with you,
What if that could be --
But for now we will dream
Of getting your autograph.

What pioneers! Movie stars, ministers, kings wanted to get his autograph.

He united the whole planet: Brazil, Guinea, Algeria, Hungary, France, Yugoslavia, Czechoslovakia, Japan, Mongolia, Berma, Salon, India, Indonesia, Nepal...

It was necessary to be deserving of this universal glory.

In France, he and Valentina arrived on the eve of the examinations at the Academy. They appeared at one town, then traveled to another. They studied the textbooks in the car.

Hero of the Soviet Union, Hero of Socialist Labor of the People's Republic of Vietnam, Hero of the Mongolian People's Republic...

Every day, every hour,
Building our futures by your model,
New heroes are born
From books written about you.

And how about he himself? What does he think about himself?

Andriyan is a man a few words. He is one of those people who would rather listen than speak, but the hardest task of all is to get him to talk about himself. We did manage to ask him several questions. We agreed that he would talk about himself in the third person as if about another man. /186

"What qualities do you value most highly in people?"

"A love of work, modesty, striving to reach a goal that they have set for themselves."

"To whom are you most indebted in your life?"

"My mother."

"Do you remember the day that gave you the greatest degree of excitement?"

"The birth of my daughter."

"How would you like to bring her up?"

"First of all, she should be a good and worthy person, valuable for our society. Simple and healthy."

"What qualities, in your opinion, should young cosmonauts develop in themselves?"

"Love of work and patience."

"What is your favorite place on this planet?"

"The central zone of our country."

"What is happiness in your view?"

"Achieving the goal that has been set."

I remembered what Boris Volynov said about him: "Andriyan pursues a goal with determination. You can't divert him, you can't stop him. Even though there isn't much time. There was a lot that had to be overcome on the way to the second space flight, but he did not turn back. It seems to me that Valya was a good support for him at that time. He is a somewhat withdrawn individual as far as his character goes, and everybody has times when he fails and wants to

crawl into a corner and not see anybody. But she is able to draw him out and raise his spirits."

From time to time, so they say, the collective skeptical voice of the cosmonaut warned me: "Just don't write about him as if it were the 'lifes of Saint Andrey', don't make an icon out of him." He's a regular fellow, he has shortcomings as well as the rest of us in general... But what does "in general" mean?

Little by little, a fellow named Anatoliy Filipchenko lifted the curtain /187
on this wonderful soul.

Nikolayev loves order. Although he is a kindly person, courteous, he does require that all instructions be carried out exactly.

"If you make order, it is necessary for everybody to do it. They tell the doctors in the dispensary to live and be good. He is a punctual fellow and if he is starting training let's say at 9 o'clock, he will come on the dot. He criticizes those who are late. He himself always sets an example, and does not make exceptions even in trifling cases. You can see how he is sitting every evening with Vitaliy, going over the whole program once again orbit after orbit. I am convinced that they will carry out the tasks faultlessly."

When a convenient situation arose, I went back to the instructor of the cosmonauts, Hero of the Soviet Union, General-Colonel (Air Force) N. P. Kamanin.

"Nikolayev can serve as an example of a communist and an officer," said Kaminin, "he is extremely tenacious, a thoughtful and serious fellow. He does not like to waste time on foolishness. He does not waste words. He undertakes all tasks with a will. He has tremendous working ability. With a great feeling of responsibility, he carries out the duties of a Deputy of the Supreme Soviet of the RSFSR. From his constituents alone, Nikolayev gets 80 to 100 letters a month, and he has to answer them all. Add to this his appearances, trips, and work. You wonder how he does it all."

I saved the last word for the man who is now working side by side with him aboard the "Soyuz-9", Vitaliy Sevast'yanov.

"I had luck with the Commander. When working with the trainers, we sometimes encountered conditionally critical situations. Under these conditions, it was necessary to rapidly evaluate the situation, perform an analysis, 'mull over' a large volume of information, and come to a correct solution. It is similar to the situation of a chess player, playing against time. In such cases, Andriyan behaves in a very firm, collected and assured /188
manner. I learned to do this from him.

"The ability to assimilate a large volume of information makes itself evident in his daily life as well. Andriyan is a very observant and curious individual, although those who do not know him well feel that he lacks this quality. It is very interesting to listen to his stories about his foreign trips. Of course, everybody projects his impressions through the prism of his 'I'. Andriyan always gives a very detailed picture; he tells about things that others don't remember.

"As a man, he impresses me very much with his modesty. Everybody wishes he could bear the 'burden of glory' for many years as successfully as he has done. He is now 40 years old, but he has been able to preserve his health. Medicine poses strict requirements for cosmonauts and they have not spared him. It takes a lot of will power to keep one's self in shape for many years. In short, I am satisfied with the Commander."

From the Generation of the Thirties /189

Time to get up. His father awoke him, saying:

"What are you doing sleeping like a Oblomov! Get up! The earlier you get up, the more you'll get done."

He learned to get up early. But is that any achievement? He is almost 35. In the Institute, the children used to say jokingly: "study -- at your age, Galois was dead already. Of course, being a great mathematician at the age of 20 like Galois is far from being his cup of tea. He is a regular candidate in the sciences. There are now 200,000 of them in the country. It is true that some of them have passed through cosmonauts' training, and some

of them know the "Soyuz" spacecraft as well as he. But it still is a specialized profession.

There is Alenka -- loving and curious. Somebody recited a legend: each of us is only half a being, and only those who find their other half will be happy. Apparently he is happy with Alenka.

This is the first year that Natasha is going to school. First time, first grade. And he is going into space for the first time. Now it seems that his dreams are being fulfilled. Enough of "flying" in trainers.

Today the medical commission is to examine him. He already passed the state exams with Andriyan. They are ready to fly. They feel great. But what do your subjective feelings amount to in comparison to the strictest council of the doctors? What if... No, I can't turn back. The most severe responsibility rests on the cosmonauts. If they fail, the labor of hundreds of thousands of people will be for nothing. He and Andriyan know that they will do everything possible (as well as the impossible). But it is not up to them now.

Time to get up. There is noise outside the window of the dispensary. /190
They get up early in Star City. There is a lot to do here...

Flight engineer of the "Soyuz-9" spacecraft, Vitaliy Ivanovich Sevast'yanov comes from the ranks of those who were in their cradles and in kindergarten before the war and are now playing the most active role in our society. His biography is similar to those of hundreds of thousands of those whose "intelligentsia in the first generation" whose parents finished three to four grades at most and that was only in the course of the elimination of illiteracy. True, their tastes, preferences, views and way of thinking are to some degree typical for the technical intelligentsia.

He likes Tolstoy, Dostoyevskiy, while his favorite poets are Pushkin and Yevtushenko. In literature, he does not value the beauty of style, but the thought, the basis of the ideas. The philosophical tones. He does not judge people by their words but by their deeds. Skepticism has achieved a wonderful coexistence in him with the romanticism of the "days of Korchagin". Of course,

he won't mention it every time you turn around, but he loves his country very much.

Naturally, he himself has not had to defend it with a weapon in his hands. But his father came back from the war with gray hair at the age of 35. But how many of his peers failed to have their fathers come home at all? For all of them, the confused thoughts of childhood are divided in half: before and after the 22nd of June.

They called his father on the third day of the war. All his life, Vitaliy has remembered the long train with the engine, the automobiles on the open platforms, the crying of women, the fathers dressed in uniforms.

Then the war years went by. His mother worked in a sewing room, for two shifts. They sewed quilted jackets and field shirts. The tiaga was all around Krasnoural'sk. In summer they gathered berries and mushrooms. Their main food supply consisted of potatoes. They got bread with ration cards.

As they sing in the song:

"What does the Motherland begin with?
With the pictures in your ABC book..."

They had only one ABC book in the whole class. Instead of ink, they used /191
a solution of soot. Sometimes the ink froze from the cold. Pens were worth their weight in gold. They whittled the penholders themselves. They would split them, insert the point and tie it up with thread. They wrote on newspapers, books, etc. -- there was no plain paper.

Now Vitaliy recalls with some pride that he only got a "5" in the fifth grade. This was in Sochi, where his family moved. The children stubbornly insist that he was born in Sochi and not in the Urals. When he visits his parents, it seems that the whole "Universe" comes to call. This one leaves his children behind when he goes to the theatre and that one drops in for the famous meat dumplings made by Tat'yana Georgieyevna. And of course everybody drinks the wine which Ivan Grigor'yevich makes himself.

Before the flight, he and Andriyan together with their backup crew had a vacation at Sochi. They went to visit his parents. The father had aged

noticeably. He was collecting his pension. He had been a driver since 1933. For almost 20 years he had been driving a taxi in Sochi. It used to be that everytime his son came, he would get him down to the garage. In the evening, he would speak as follows: "Tomorrow I'm having an inspection and I have to rotate the wheels -- can you help me?" You know, although you are a candidate preparing for a trip to the stars, that you must not forget labor has made man.

Who made a man out of him? His parents, of course, and school.

They have a nice school, named after Nikolai Ostrovskiy. And it is a "Korchagin" school not only in name but in spirit. On this occasion, Vitaliy visited the shaggy headed children in blue jackets and with the letter "K" in their shoulder patches, standing for Korchaginists. The pioneer group took the name of Pavka Korchagin and the children took his picture; the romantic aspects of the revolution excited them no less than they excited him.

As before, those entering school encounter the burning words of N. Ostrovskiy:

"The most precious thing that man owns is his life. It is given to him only once, and he must live it so that he will suffer no pangs of having lived for years to no purpose..." /192

The class had its own motto: "Let us dedicate our finest moments to the Motherland."

The school motto became a rule of life for Sevast'yanov. I look at his strict countenance on the stage beneath the portrait of Lenin. A traditional Party gathering of the Communists at Star City is taking place.

V. A. Shatalov has just delivered a report entitled "The Readiness of the Cosmonauts to Carry Out the Tasks of the Motherland." Andriyan Nikolayev has spoken. Now Communist Sevast'yanov is talking. His voice is calm and assured:

"We shall use all of our knowledge, skill, forces, willpower in order to carry out the tasks assigned by the nation..."

They wish him a safe takeoff and a soft landing.

How did it come about that he became a cosmonaut?

The first book he read was called "The Drivers of the Frigates". That was back in kindergarten. It was out of that book that he learned to read. Word by word at first, then faster. He wanted to find out as quickly as he could what would happen in the far off seas with the daring Cook and Laperuse. Like all little boys, he dreamed of "running away to be a pirate". After the seventh grade, he decided to go to the Batumi High School of Navigation. He even received a medical commission. But his father objected:

"Finish the tenth grade and then you'll be able to choose your profession."

He understood that the interests of his son had not been stabilized as yet, and he turned out to be right. In the eighth grade, Vitaliy became the monitor of the physics club. After the war, physics rapidly came into fashion. The secret power of atomic energy had a particular attraction for youth. He was no exception. Korsunskiy's book, "The Atomic Nucleus" was in tatters by the time Vitaliy finished reading it. He began to investigate chain reactions. He understood the essence of Rutherford's discoveries. He himself built a Wilson chamber, one of the essential pieces of apparatus for studying the /193
world of the very small.

The enthusiasm for the sea did not disappear. It only made room for something else. In the summer, he went to the yacht club. One year he worked as a sailor on a boat that traveled between Sochi and Khostoy.

When time came to choose an Institute, Vitaliy understood that for him physics was still simply a "confession to the times". He wavered between shipbuilding and aviation -- between two elements. An he chose aviation, although he had never flown in an airplane before that. Apparently his desire had always been to be at the leading edge, always working on something new. In my opinion, this is one of the outsanding features of his nature.

The beginning of the 1950's was filled with the howl of jet aviation, "the explosions" of shock waves from aircraft breaking the sound barrier.

Naturally, it seemed to him that aviation had the most promising future. He began his studies at the aircraft design department of the Military Aviation Institute. He himself wanted to design the fastest and highest-flying machines. He finally achieved this goal in cosmonautics.

In his first course, he saw a sign somewhere that read: "Everybody join the high-altitude flight club." It developed that the senior students were getting ready to work with the theory of rocket propulsion by studying the works of Tsiolkovskiy. They had only a very general idea about Tsiolkovskiy at that time. But they read everything there was in the Institute Library and then went to the Lenin Library. As is always the case with Sevast'yanov, he wanted to try his wings too. He occupied himself with the problem of return from space. In 1956, his work entitled "The Return of a Winged Apparatus From the Orbit of an Earth Satellite" was awarded first prize at the State Examination of Student Papers.

In the fifth year, at the request of a students' scientific technical society, four of them decided to make their class project nothing more or less /194
than a multistage rocket for launching a satellite weighing 50 kilograms.

The project was almost ready when the stunning news came that the first artificial Earth satellite weighing 83 kilograms has been launched into space. They were confused, then someone shyly proposed, let's build one weighing 100 kilograms. For several nights in a row they did not sleep -- they were redesigning the entire project. What computers they were! They used only a simple logarithmic slide rule. When the four of them were already looking forward with pleasure to their "victory", the second Earth satellite weighing half a ton was launched. The only conclusion that remained for them was they were no match for their mysterious "rivals".

When the first group of cosmonauts was formed, Vitaliy had already absorbed fundamentals of space technique used by Gagarin, Titov, Nikolayev, Popovich, Komarov, Bykovskiy, and Khrunov. Star City then consisted of only one building with freshly painted floors. He spotted it, and grew with it.

Vitaliy is not one of those who can sit on the sidelines and not take part. He himself wanted to be a subject for space technology. He passed the

tests of the medical commission and a sequence of tests on centrifuges, anechoic chambers, weightlessness, thermobarochambers, acting as backup pilot, restrictions of training regimes.

The profession of a cosmonaut is like an iceberg. All anybody can see is the flight and the glory. All of the preparation is what they refer to as the "tears invisible to the world". And this gives rise to false rumors.

But it is senseless to argue with people who "think that the best books are bank books and the best films are those made to entertain." Even if they looked at these films on the screens of their television sets at home, somewhere in the far north or the far east, they fail to comprehend that without the "Molniya" satellites they would not be able to see them. Even if they /195
put on clothing, believing the forecast received with the aid of the meteorological satellites, they will still grumble that nobody needs space. Even if some day one of them can fly to the other side of the Earth in an hour on a rocket plane, he will not remember the cosmonauts who are working at the present time so that this will be possible in the future.

The cosmonauts are test pilots. They are going into the unknown. And they are doing what no machine is presently able to do.

True, they do get a lot of glory, more than the founders of space technology receive. True, they personify the labor of thousands of people. But they also have to accept the risks of the test pilot and the painstaking unseen task of mastering a new technique, which now requires so much knowledge in so many different fields.

Even when he was in school, Sevast'yanov built complicated radio amplifiers and was designing spacecraft when he was still a student. Rest assured -- he knows his technology. But he is far from unique. He himself was Yeliseyev's backup pilot. Now two flight engineers were ready to take his place. They know the business as well as he. It was simply his turn.

Vitaliy always wanted to leave his mark in cosmonautics, to "cut out" a step on which others can climb up higher. He is one of those who believes that these steps on the ladder to space will go beyond the limits of the

solar system and man will be able to fly to the stars. It is going to take time, but he will fly there! And one of the steps on this flight will have been created by himself and Nikolayev.

Star City

B. Konovalov,
Special Correspondent
of *Izvestiya*

Decree

Of the Presidium of the Supreme Soviet of the USSR
On the Award of a Second "Gold Star" Medal to Hero
of the Soviet Union, Pilot-Cosmonaut of the USSR
Comrade A. G. Nikolayev

For his successful accomplishment of a long orbital flight aboard the "Soyuz-9" spacecraft and for the courage and heroism displayed on this occasion, a second "Gold Star" medal is awarded to Hero of the Soviet Union, Pilot--Cosmonaut of the USSR, Comrade Andriyan Grigor'yevich Nikolayev.

Chairman of the Presidium of the
Supreme Soviet of the USSR,
N. Podgornyy

Secretary of the Presidium of the
Supreme Soviet of the USSR,
M. Georgadze

Moscow, The Kremlin, 3 July 1970

Decree /228

Of the Presidium of the Supreme Soviet of the USSR
On the Awarding of the Title of Hero of the Soviet
Union to Pilot-Cosmonaut Comrade V. I. Sevast'yanov

For his successful accomplishment of the long orbital flight aboard the "Soyuz-9" spacecraft and the courage and heroism displayed on that occasion, the title of Hero of the Soviet Union and the Order of Lenin, as well as the "Gold Star" medal are awarded to pilot-cosmonaut Comrade Vitaliy Ivanovich Sevast'yanov.

Chairman of the Presidium of the
Supreme Soviet of the USSR,
N. Podgornyy

Secretary of the Presidium of the
Supreme Soviet of the USSR,
M. Georgadze

Moscow, The Kremlin, 3 July 1970.

Decree /229

Of the Presidium of the Supreme Soviet of the USSR
Award of the Title of "Pilot-Cosmonaut of the USSR"
to Comrade V. I. Sevast'yanov

For accomplishing the space flight aboard the "Soyuz-9" spacecraft, the title of "Pilot-Cosmonaut of the USSR" is awarded to citizen of the Soviet Union, Comrade Vitaliy Ivanovich Sevast'yanov.

Chairman of the Presidium of the
Supreme Soviet of the USSR
N. Podgornyy

Secretary of the Presidium of the
Supreme Soviet of the USSR,
N. Georgadze

Moscow, The Kremlin, 3 July 1970

The Homeland Honors the Space Heroes /230

Reception at the Grand Kremlin Palace

In the name of our Motherland, Moscow extended its warm and heartfelt greetings on the 3rd of July to the members of the crew that had completed a space voyage aboard the "Soyuz-9" spacecraft.

The reception at the Kremlin was an expression of the love of the entire nation for cosmonauts A.G. Nikolayev and V.I. Sevast'yanov, pride at their achievement, recognition of the debt owed to the scientists, designers, engineers, technicians and workers who made possible the successful accomplishment of the flight. The reception was organized by the Central Committee of the CPSU, the Presidium of the Supreme Soviet of the USSR and the Council of Ministers of the USSR.

In the sparkling lights of the Georgian Hall of the Grand Kremlin Palace, the members of the Central Committee of the Communist Party of the Soviet Union, candidates for membership in the Central Committee of the CPSU, members of the Central Revisionary Commission of the CPSU, Ministers, Directors of Central Organizations, representatives of the community and the workers of the capital, military leaders, pilot-cosmonauts of the USSR, persons active in science and culture all were gathered.

In addition, those who are building a new era in space technology came to the Kremlin. Their creations are the powerful rocket which will lift our interplanetary station, satellites and manned spacecraft into the sky. Together with the heroic crew, they can say with justifiable pride: "The task of the Party, the Motherland and the people has been successfully accomplished!"

The atmosphere in the Grand Kremlin Palace was truly that of an international holiday.

It is 6 p.m. The following people enter the Hall: Comrades L. I. Brezhnev, G. I. Voronov, A. P. Kirilenko, A. N. Kosygin, K. T. Mazurov, A. Ya. Pel'she, N. V. Podgorniy, D. S. Polyanskiy, M. A. Suslov, A. N. Shelepin, P. Ye. Shelest, Yu. D. Andropov, V. V. Grishin, P. N. Demichev, D. A. Kunayev, P. M. Maherov ,V. P. Mzhavanadze, Sh. R. Rashidov, D. F. Ustinov, V. V. Shcherbitskiy, I. V. Kapitonov, K. F. Katushev, F. D. Kulakov, B. N. Ponomarev , and M. S. Solomentsev. They were accompanied by the President and Prime Minister of the United Arab Republic, the Chairman of the Arab Socialist Union, Gamal Abdel Nasser, member of the Supreme Executive Committee of the Arab Socialist Union, Ali Sabry, Official personnel accompanying the President of the UAR. There were also members of a delegation from the Budapest City Committee of the Hungarian Socialist Workers Party together with the candidate for membership of the Politburo of the Central Committee of the Hungarian Socialist Workers Party, First Secretary of the City Committee of the Party, K. Nemet, and other foreign guests. /231

and the Soviet government warmly.

The strains of the tune "Slav'sya!" by Glinka sounded beneath the arches of the hall. Stormy applause greeted the arrival of A. G. Nikolayev and V. I. Sevast'yanov. They approached the leaders of the Party and government. The Commander of the craft could be heard as he reported on the successful completion of the tasks of the Motherland, and the readiness of the cosmonauts to carry out new tasks.

The leaders of the Communist Party in the Soviet government greeted the heroic crew which had written a new page in the history of the conquest of

space, bringing new honor to the Soviet Union which had laid the foundations of the space age. The General Secretary of the Central Committee of the CPSU, Comrade L. I. Brezhnev, addressed those present.

Speech of L. I. Brezhnev /232

Dear Comrades!

We are gathered here today to extend our warm greetings to the heroic crew of the "Soyuz-9" spacecraft, the Commander of the ship, the well-known pilot-cosmonaut, hero of the Soviet Union, Colonel Andriyan Grigor'yevich Nikolayev and flight engineer, candidate in technical sciences, Vitaliy Ivanovich Sevast'yanov. (Applause).

We extend our sincere greetings to these outstanding heroes on the successful accomplishment of the space flight which they have made, during which they completed 286 revolutions around our Earth! (Applause).

Never before has anyone spent as long a time in space as Comrades Nikolayev and Sevast'yanov. This was a test of endurance and ability to work, not only for all of the systems of the craft, but especially for the cosmonauts themselves. And we note with tremendous satisfaction that this test was passed with honor! (Applause).

Time after time, following each new flight of these outstanding cosmonauts, we are convinced that man continues to go into space more and more confidently and with more knowledge behind him. From the romantic nature of the first contact with the unknown world, from the brave encounter with this unfamiliar world, its dangers and uncertainties, space flights (even with all the difficulties and dangers involved) are becoming, so to speak, more and more of an everyday occurrence. They have become in particular the most complicated and responsible work in the name of science, in the name of the real interest of the people. In this connection, the flight of Comrades Nikolayev and Sevast'yanov was particularly significant. They proved themselves to be not only outstanding, courageous and skilled navigators in the ocean of space, but also as outstanding workers in space. For 18 days, they carried /233 out an extensive and complicated program of scientific research studies in

space, according to the instructions of Soviet scientists. They made an important new advance in the conquest of space, making an important contribution to the development of many branches of science, the improvement of flight techniques for space.

However, the principal goal of the flight is the fact that the possibility has been demonstrated of man being able to stay not only for days but for weeks, living and working in space under conditions of weightlessness. It is a great and joyful experience to see Andriyan Grigor'yevich and Vitaliy Ivanovich after their record endurance flight in space, healthy, vigorous and cheerful! (Loud, prolonged applause).

It is clear to everyone that a long space flight of this kind makes tremendous claims on the courage, endurance, and devotion to duty on the part of those involved. These qualities were displayed in full measure by the members of the Communist Party, the sons of our Motherland, the Commander of the craft, veteran cosmonaut Comrade Nikolayev and flight engineer, the young scientist, Comrade Sevast'yanov.

It is with great satisfaction that I tell you, Comrades, that the Presidium of the Supreme Soviet of the USSR, in view of the courage and heroism displayed during the space flight aboard the "Soyuz-9", has awarded a second "Gold Star" medal to Hero of the Soviet Union, Pilot-Cosmonaut of the USSR, Comrade Andriyan Grigor'yevich Nikolayev. (Loud, prolonged applause). He has also been awarded the military title of Major General in the Air Force. (Loud applause). Comrade Vitaliy Ivanovich Sevast'yanov has been awarded the title of Hero of the Soviet Union with the Order of Lenin and the "Gold Star" medal, together with a title of "Pilot-Cosmonaut of the USSR". (Loud, prolonged applause).

Allow me in the name of the Central Committee of the Party, the Presidium of the Supreme Soviet and the Council of Ministers of the USSR, to extend my warm greetings to the hero-cosmonauts on the outstanding achievement of the tasks of the Party and government in the name of high purposes. (Prolonged applause). We wish them great new successes in their work on behalf of our nation, we wish them good health and happiness! (Prolonged applause). /234

Comrades!

Thousands of people took part in the construction of the "Soyuz-9" spacecraft to make possible its flight and the work of the crew. These are the outstanding scientists, designers and workers, outstanding specialists, experts in modern technology -- in a word, a great army of selfless enthusiasts of cosmonautics. As is always the case in these situations, our thoughts turn to them and we feel appreciation and gratitude. (Prolonged applause). Their activity shows a high level of a love for the Motherland and for the entire Soviet people.

We can say with certainty that the creative thoughts, the skilled hands and the unflgging labor of this cosmic brigade of ours will make it possible for our Soviet ships to go up into interplanetary space, to create new achievements for our outstanding Soviet cosmonauts, making new discoveries and peaceful conquests in space in the interest of science and the national economy.

Allow me comrades to propose a toast:

-- To the glorious crew of the "Soyuz-9" spacecraft -- comrades Nikolayev and Sevast'yanov, who have successfully completed the tasks of the Motherland and have served admirably in the name of the highest goals!

-- To all Soviet cosmonauts -- the courageous sons of our Motherland!

-- To the terrestrial army of conquerors of space -- to the Soviet scientists, designers, to the engineers, technicians and workers, to their great work, so important for the Motherland and all of mankind!

-- To the new victories of Soviet people in all fields of the building of Communism! (Loud, prolonged applause). /235

The Chairman of the Presidium of the Supreme Soviet of the USSR, N. V. Podgornyy, read the decrees of the Presidium of the Supreme Soviet of the USSR honoring the cosmonauts.

--"Allow me, dear comrades," said N. V. Podgornyy, "to award the highest honors of the Soviet government, in the name of those present here, in the name of all Soviet people, extending warm greetings to Comrades A. G. Nikolayev

and V. I. Sevast'yanov, with a well deserved praise for the heroism and self-sacrificing labor; we wish them new achievements and successes for the glory of our great Motherland, perfect health, as well as great personal happiness for them and their families!"

The great moment had come. N. V. Podgornyy awarded A. G. Nikolayev the second "Gold Star" medal, while V. I. Sevast'yanov received the Order of Lenin, the "Gold Star" medal and the title of "Pilot-Cosmonaut of the USSR."

Each of the pilot-cosmonauts firmly declared: "I shall serve the Soviet Union!"

Those present applauded loudly. The leaders of the Party and government shook hands warmly with the two heroes of the Soviet Union, A. G. Nikolayev and V. I. Sevast'yanov, congratulating them heartily. They wished them new successes in the name of the honor of our socialist Motherland.

A. G. Nikolayev thanked the Central Committee of the Communist Party of the Soviet Union, the Presidium of the Supreme Soviet of the USSR, the Council of Ministers of the USSR for the recognition shown to him and Sevast'yanov in appreciation for carrying out the multi-day space flight aboard the "Soyuz-9" spacecraft.

We were deeply touched by the warm words spoken by Leonid Il'ich Brezhnev /236
and Nikolai Viktorovich Podgornyy to the cosmonauts, and the high opinion of our flight, said the commander of the craft. From the bottom of my heart, I express my gratitude for the high government honors which we received today.

Our multi-day flight has ended successfully. The crew of the "Soyuz-9" has carried out completely the extensive program of scientific and technical and medical-biological studies and experiments, tested new apparatus and systems under conditions of prolonged flight. The apparatus and all systems of the craft operated reliably, and the "Soyuz" spacecraft has displayed its high qualities once again. In the name of the cosmonauts, I express my most sincere gratitude to the scientists, designers, engineers, technicians and workers who built the "Soyuz" spacecraft.

We are happy that our flight took place during the Lenin Jubilee year. During the space flight, we were always aware of the interest and concern of the Party, government, and all Soviet people and tried to do our best to accomplish this responsible task.

In the name of the other cosmonauts, A. G. Nikolayev said that they would spare no effort to carry out new tasks of the Leninist Party and the Soviet government for their further conquest of space.

After thanking the Leninist Central Committee of the Party, the Presidium of the Supreme Soviet of the USSR and the Soviet government for their great trust, as well as their high opinion of the work accomplished by those who participated in this long space flight, V. I. Sevast'yanov said:

"Our flight was properly called a working flight. Its program really was extensive, very interesting, and quite full. During the flight, we carried out a great many important technical and scientific investigations that will be significant for the popular economy. One of the tasks which we had to do /237
was the complex testing of the "Soyuz-9" spacecraft and working with it's onboard systems during the long space flight.

The flight engineer told about other tests, emphasizing that a lot of time would be needed to analyze all of the data that had been obtained.

V. I. Sevast'yanov said that the elections to the Supreme Soviet of the USSR were an important event in the life of our people. For us in space, this day was also a holiday. Aboard the craft, we sent a telegram in which we said that we took pleasure in joining the heroic Soviet people composed of the unbreakable alliance of communists and non-communists, for the further glorification of our socialist Motherland, our Communist Party, and communism.

The speeches of the cosmonauts were greeted by applause.

A. G. Nikolayev and V. I. Sevast'yanov were approached by the guests at the reception, foreign diplomats, guests from abroad, who expressed congratulations to them for their courage and heroism. All showered praise on the members of the "Soyuz-9" crew.

The reception for the space heroes was joyful, exciting and heartwarming. The reception at the Grand Kremlin Palace clearly demonstrated the high opinion which the Party and the people have of this great new step in the conquest of space, an important contribution to the development of many branches of science, and an advance in the technology of space flight.

The two Soviet cosmonauts showed that man can live and work in space for long times, under conditions of weightlessness. This is a new victory for our science, and for our entire heroic people.

(TASS).

The Highest Honor of the UAR Awarded to the Pilot-Cosmonauts /238

The President of the United Arab Republic, Gamal Abdel Naser, recognizing the great significance of the space flight made by the "Soyuz-9" for the development of science, conquest of space on behalf of all mankind, awarded twice Hero of the Soviet Union, Pilot-Cosmonaut Major General in the Air Force, A. G. Nikolayev and Hero of the Soviet Union, Pilot-Cosmonaut V. I. Sevast'yanov, the highest honor of the United Arab Republic -- the Order of the "Necklace of the Nile".

(TASS)

Vitaliy Sevast'yanov -- Honorary Citizen of Kaluga

The flight of the "Soyuz-9" spacecraft was followed with great interest in the old Russian city on the Oka, a city where the founder of cosmonautics K. E. Tsiolkovskiy lived and worked. The Commander of this craft was an honorary citizen of Kaluga, A. G. Nikolayev.

From now on, cosmonaut V. I. Sevast'yanov is also an honorary citizen of Kaluga. This was decided by an executive committee of the Kaluga Town Council of Workers' Deputies.

Kaluga